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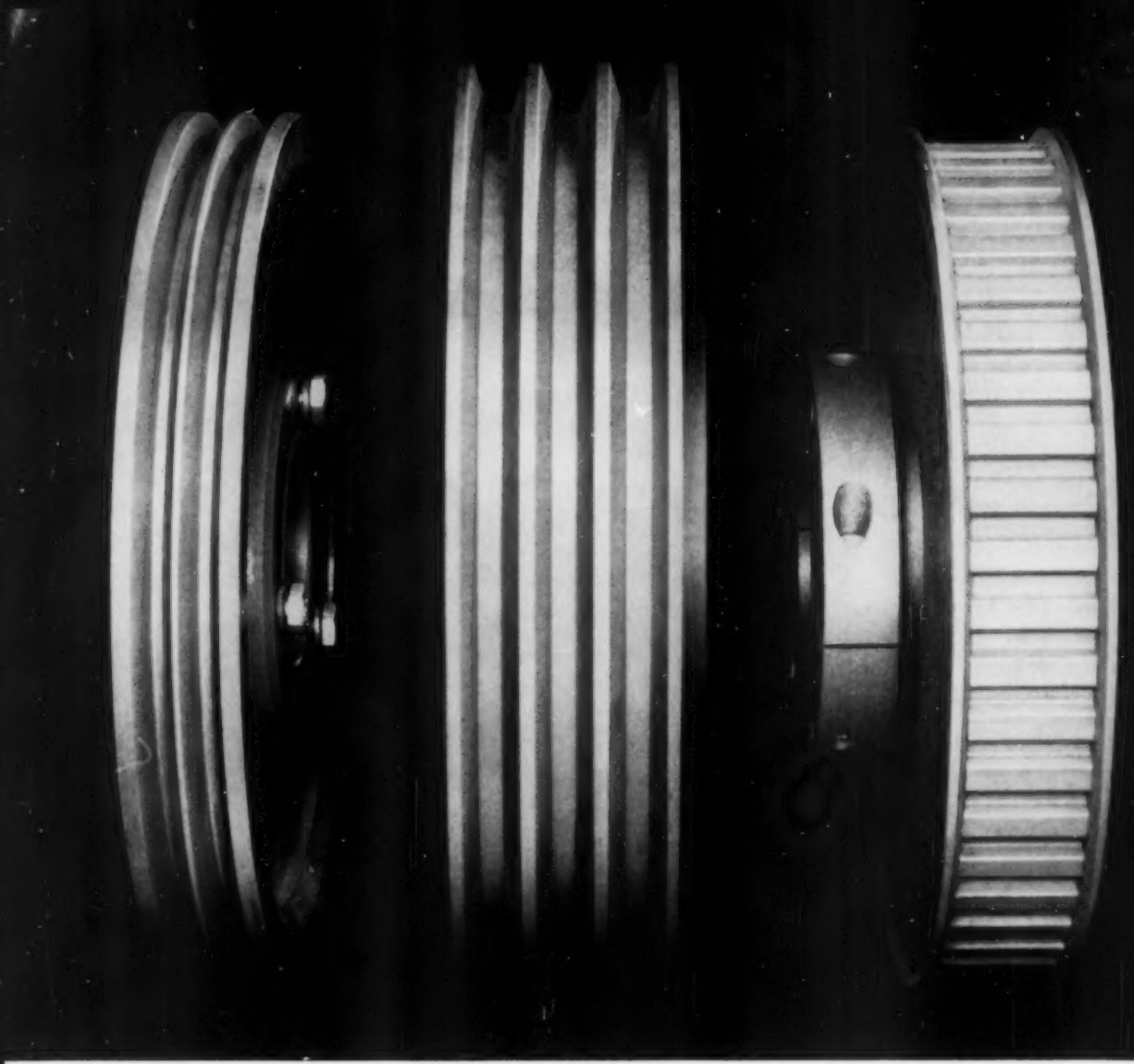
PRODUCT ENGINEERING

GRAW-H... WEEKLY OF DESIGN RESEARCH AND DEVELOPMENT OCTOBER 3, 1960

HOW BRIGHT THE LIGHT ?

see page 3



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FIRST, LOOK AT THREE

Measured by horsepower handled, the three wheels shown are the same. But Multi-V (long the industry favorite) is bulky, as compared with the new lighter, equally strong Multi-Wedge Drive. And the Positive Drive combines advantages of the chain and gear with the advantages of the belt.

For all three, even in fractional sizes, Worthington supplies the tapered, split QD hub with the Golden Screws. Or, of course, it supplies bored-to-suit hubs for special applications. And for every drive, from 1/20 hp to 600 hp or more, the proven Worthington-Goodyear belts are supplied. In fact, the QD hub plus these belts in any of the above three drive types make them most compact, flexible and long-lived.

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PRODUCT ENGINEERING

McGRAW-HILL WEEKLY OF DESIGN, RESEARCH AND DEVELOPMENT

October 3, 1960 Vol. 31, No. 41

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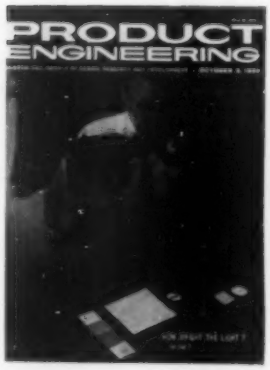
INTERESTING TO NOTE



On our cover—The instrument-lighting laboratory at General Electric's Instrument Dept, West Lynn, Mass. The engineer, John L. Frazier, is shown making a routine inspection of the brightness level of an experimental aircraft-instrument-dial face. Color patches in foreground are samples of electroluminescent lighting material undergoing life test. (See article, p 41.)

Electroluminescence is the first new concept in lighting since 1920, when fluorescent lights appeared in Paris as an outgrowth of Georges Claude's invention of the neon tube. Today, fluorescent lamps are supplying the US with more light than any other man-made light source.

One problem facing developers of electroluminescent materials is efficiency. Early panels were only 2% efficient, but engineers feel this can be raised to 50%. Even this low original figure is far better than for Edison's first bulbs, which were only 0.4% efficient. Modern 100-watt bulbs are just 4% efficient; modern fluorescent lamps, 16%.

Although electroluminescence is the newest form of artificial lighting, glowing phosphors have been observed in nature for thousands of years. The strange, eerie light has been observed in the forests of the Mato Grasso in Brazil, and in the ocean deeps. The technique of exciting phosphors by an alternating electric field was discovered by a Frenchman, George Destriau, in 1936. He placed some zinc sulfide phosphors in a strong alternating field and observed a faint glow. (His observation has since been called the Destriau effect.) The concept that phosphors could be excited by an electric field was at first questioned; however, intensive research proved out Destriau's theory.

A Salty Tale

That familiar saltcellar on the dining room table contains just about the most inexpensive item on the food budget today. The few pennies we pay our grocer for a container of salt are mostly for packaging and shipping. However, it wasn't always cheap. In early times salt was so scarce and desirable it was used as money. (The word "salary" is derived from the Latin *salarium*, meaning "salt.") When a man did a good day's work or a soldier displayed valor, he was said to be "worth his salt."

Salt has also played an important role in American history. During Colonial times, it was the only substance known to preserve meat and was imported in great quantities. When the Revolutionary War began, the British Navy effectively blockaded our coast, cutting off our salt supply. The Continental Congress appropriated funds and authorized salt works along the shore, even exempting the workmen from military duty so they could produce salt from sea water. Shallow ponds were built, then blocked

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off at high tide. The water was evaporated by sun and wind. Sometimes the sea water was evaporated in large iron cauldrons. The foul-tasting impurities, called "bitters," were removed and the end product was sold in baskets for about $6 a bushel. Black Marketeers got as much as $15 a bushel. Naturally, the British organized many a raid by land and sea to destroy our shore installations. Obtaining salt from the sea is still a problem; however, as the news story on page 15 points out, we're getting closer to an answer.

Hurricane That Saved England

During the mid 1930s the English air ministry was in search of a new plane. Since World War I, the RAF had been flying biplanes with a top speed of 250 mph; although they served their purpose, by war's end they were obsolete. The man who had the plane for England's needs was a 39-year-old chief designer at Hawker Aircraft Ltd, Sydney Camm. The fact that a monoplane had recently won the Schneider Trophy at the then unheard of speed of 328 mph convinced Camm that a monoplane was the only plane for the RAF. In his new book, *The Hurricane Story*, Paul Gallico describes the problems Camm had in convincing the British Air Council to spend money on a plane that was untried and expensive.

Camm's initial request before the council was rejected as being too revolutionary. However, neither Camm nor Hawker was dismayed—the company decided to continue the project as a private venture, calling the new ship the Hurricane. Then, in 1935, the Air Council ordered one prototype, which was ready for a ground test in the amazing time of one month. For another six months the plane went on being tested and retested. Improvements were added: better hydraulic fluids, stronger gaskets (see p 52); an efficient coolant. By November, members of the Air Ministry were ready to witness its first flight. Famed

Hurricanes over England *Central Press Photo*

test pilot George Bulman was asked to do the job. The test was about as smooth as a test flight could be. When Bulman landed and taxied to the waiting dignitaries he leaped from the plane, shook Sydney Camm by the hand and joked, "It's a piece of cake. I could teach you to fly her in half an hour, Sydney." Britain had the beginnings of a modern air force. And she would have had an airplane ready to meet the Luftwaffe when the Battle over Britain began. —Benedict A Leerburger Jr

NEXT WEEK IN PRODUCT ENGINEERING

. . . **Design Nomographs the Easier Way**

Once the equation has been put into the proper determinant form the nomograph is, to all intents and purposes, done.

. . . **Better Way to Place Sliderule Decimal Point**

"Supes" and "subs" avoid those pesky errors—without increasing computation time.

. . . **Introducing the Flexagage**

A resistance strain-gage sandwich that effectively distinguishes bending strain from axial strain, but with a pair of metal-foil elements mounted outside the structure being tested.

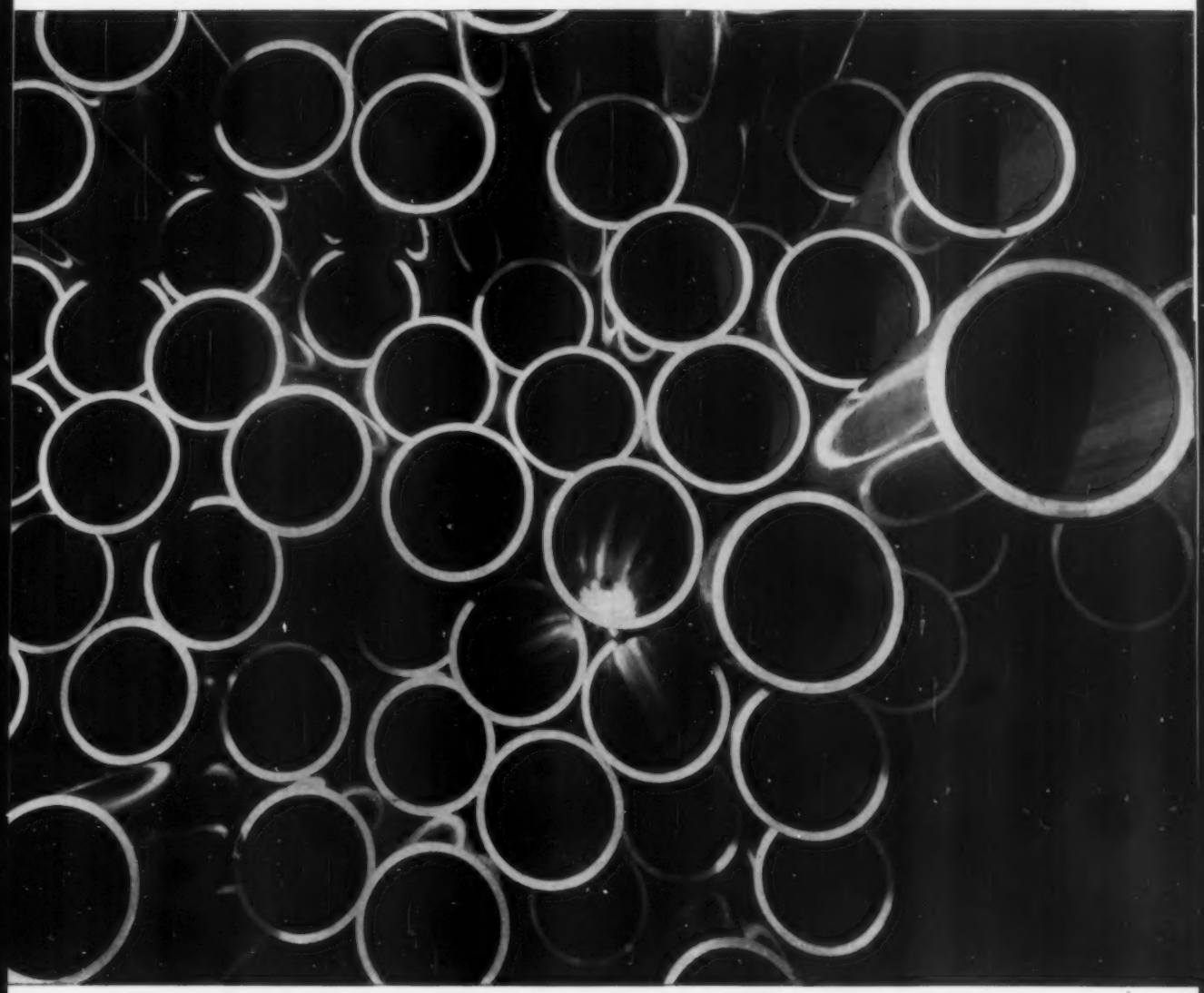
. . . **Vibration Resistance of Thread-locking Devices**

New test method rates how various ESNA-type locknuts perform during vibration, and how they compare with plain nuts.

. . . **Handles for Printed Circuits**

Seven simple designs for making maintenance easier.

This mark tells you a product is made of modern, dependable Steel.



Look at the dimensional accuracy and smoothness

You can reduce the costs and processing time of parts-making by using USS National Electric-Resistance Welded Mechanical Tubing. It eliminates drilling operations. It lets you replace drills with simple, less expensive boring tools. Mechanical Tubing reduces tool wear and tool changes.

USS National Electric Welded Mechanical Tubing is an ideal load-carrying member. It resists bending stresses equally in all directions and gives you a superior cross section. It absorbs and localizes shock. In torsion, it provides better material distribution. And for a given weight, mechanical tubing withstands more load than other sections.

USS National Electric Welded Mechanical Tubing is available in cold-drawn or hot-rolled sizes ⅜″ thru 5½″ and in wall thicknesses .035″ to .250″. It can be obtained from National Tube Distributors located throughout the country. They will gladly show you how to use USS National Welded Mechanical Tubing in your next application. *See your USS National Tube Distributor.*

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National Tube Division of United States Steel

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United States Steel Supply Division
United States Steel Export Company, New York

CIRCLE 5 ON READER SERVICE CARD

DEVELOPMENTS TO WATCH...

Spring-loaded plugs improve electrical connections

A plug design that "provides maximum contact surface for minimum specific contact pressure" is reported from Switzerland.

The unit, developed by Multi-Contact, Sonnengasse 48, Basle, features multiple built-in contact springs (42 of them in a 4-mm unit, for instance) arranged to form a cylindrical jacket serving as a contact surface. The springs are fastened at one end; the other is free to move longitudinally.

Multi-Contact says contact pressure can be individually selected for special constructions by using different forms of grip and altering magnitude of clamping angle.

Several types have been designed: single and double connectors, with metal and plastic bodies; and plug-through sockets. The latter are readily removed and replaced, and can be adapted to latching assemblies, V-block distributors, and terminal blocks.

Full information is available directly from the company in French, German, and English.

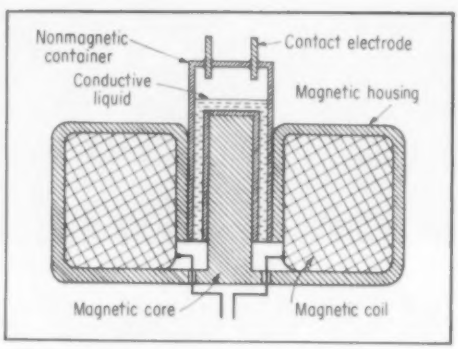
Better asbestos insulation claimed by German manufacturer

An improved type of asbestos insulation, in which silicone resin serves as a binder, is being made by Wacker-Chemie GmbH, Munich. An OEEC report says the material is 4 times as strong in one direction, 3 times as strong in the other, as comparable materials made with other binders. Furthermore, it shows almost no change after heating to 480 F for 24 hr or after immersion in water for the same period.

The binder is said to be a special formulation, a 50% resin emulsion which is stable in the uncombined state, but reacts with the asbestos fibers to form an adherent surface on them and hold them tightly together. Electrical as well as thermal properties are said to be excellent.

New relay has liquid-metal contacts

A new relay takes advantage of eddy currents generated in a liquid to effect a displacement in a magnetic field—no mechanical linkages or other moving parts needed. In this respect, it differs from another recently developed liquid-metal switching device (*PE*—Aug 29, p 8) which takes its action from the change in resistivity of a column of liquid metal draining from a container. The latest one creates motion within the liquid, and uses that motion directly.

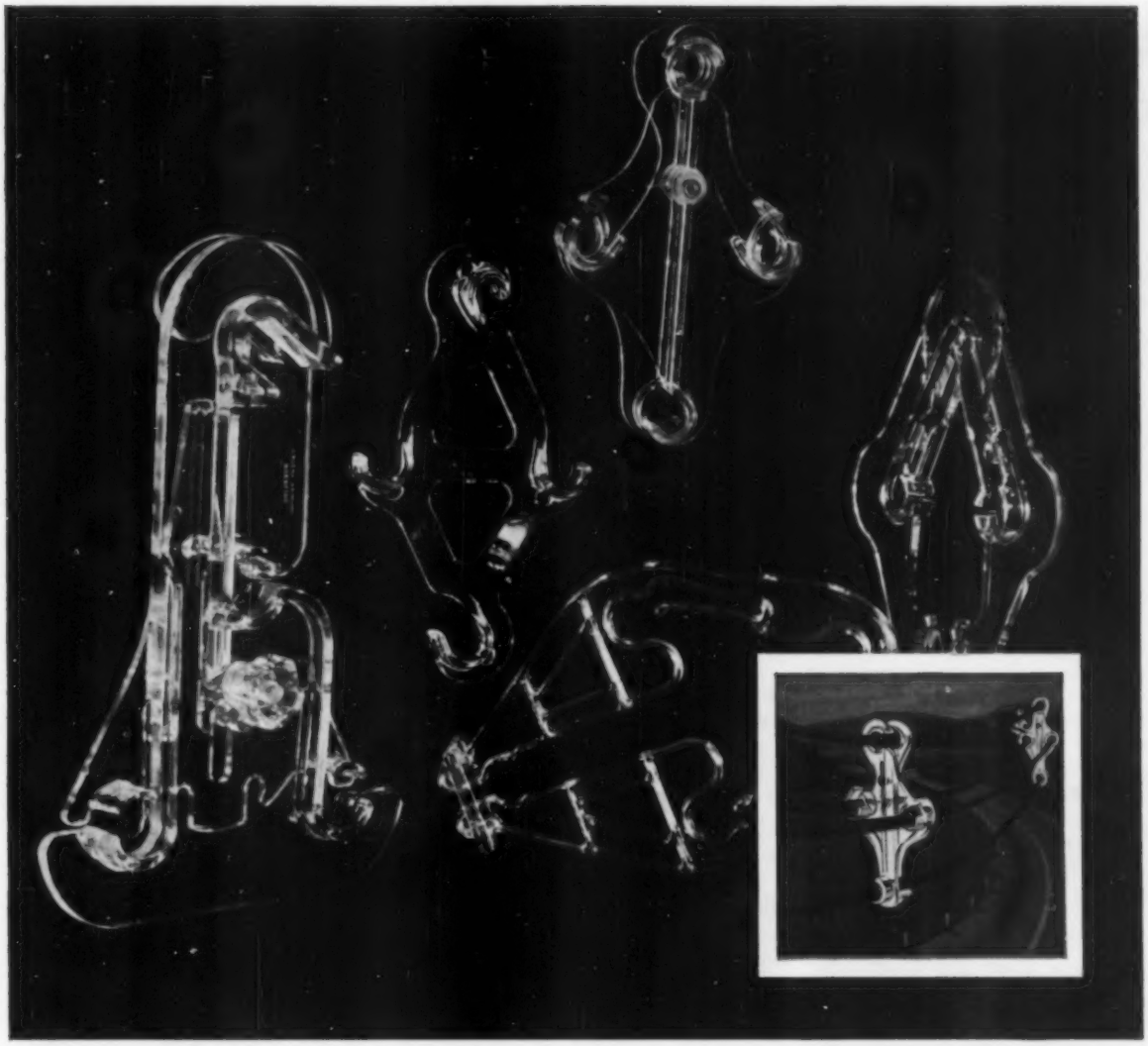


LIQUID METAL, in annular container supported between coil and core, moves in response to applied current, making and breaking contact.

Its liquid metal is contained in a cylindrical, sealed nonmagnetic container with an annular base. The container is supported within a magnetic coil and the whole unit is encased in a magnetic housing (see diagram). Electrical contacts extend into the upper portion of the container. When ac current is passed through the coil, eddy currents are induced in the liquid. Interaction between these currents and the magnetic field produces a force on the conductive liquid perpendicular to the field, which moves the liquid upward in its container, bridging the electrical contacts and making the circuit.

Minneapolis-Honeywell, which has patented the device, points out that it is noiseless in operation, has no sliding parts to wear, should be unusually reliable in operation. Furthermore, it can be adopted to a wide temperature range through use of various "liquids" and containers. (In the prototype, the liquid is the low-melting (10 F) sodium-potassium eutectic, and the container is glass.)

continues on p 8



Cable spacers demonstrate strength and durability of

PLEXIGLAS

Shown above are some of the many types of aerial spacers—used to support and separate electric power lines—that are being molded of PLEXIGLAS® acrylic plastic. Why? Because PLEXIGLAS provides the strength, weather resistance and electrical properties needed to meet the rugged service requirements involved in this application. In addition, PLEXIGLAS can be molded accurately to the intricate clamp designs and contributes the light weight that is so important in these massive moldings.

Does this dramatic example of the advantages of PLEXIGLAS give *you* an idea for its use? We will be glad to send you full details about this quality molding material, and to provide design assistance on specific projects.

Chemicals for Industry

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WASHINGTON SQUARE, PHILADELPHIA 5, PA.

In Canada: *Rohm & Haas Company of Canada, Ltd., West Hill, Ontario*

Combination flexible coupling and slip clutch offered by British

A light-duty unit designed to prevent motor stalling and burnout when limit switches fail has been designed by Metaducts Ltd, Catherine Wheel Road, Brentford, Middlesex, England. The unit combines a flexible coupling with an adjustable friction clutch in one low-cost component that offers a greater controllability than can be obtained with shear pins, and smaller size and cost than centrifugal clutches designed for this purpose.

In the first model to be introduced (3¼ in. OD) the slipping torque is adjustable up to 5 ft-lb (by adjusting 3 bolts holding the plates in contact by spring pressure). Price is in the $9 to $10 range.

Lower prices promised for natural rubber

"Natural rubber will stay competitive," the director of the Natural Rubber Bureau said not long ago. And it looked as if he meant it. Base price dropped 5¢ a lb in the month after he made the remark; and a new technical program to improve rubber quality was initiated.

Recently, the price of rubber has started up again, reflecting the fact that consumption has outdistanced supply. But the price is still far from this year's high, and the long-term trend should be in a downward direction. The rapid growth of synthetic rubber capacity outside the US, where natural rubber, until very recently, had relatively little competition; and increasingly high percentage of synthetic used here (an all-time high of nearly 70% was recorded last month), should keep natural-rubber producers on their toes.

Czechs claim novel meter for measuring ac voltage peaks

A voltmeter of the compensation type, in which a dc amplifier is used to permit accurate determinations of ac voltage peaks in the 1- to-100-volt range, is claimed by Czech engineers.

Basically, it is similar to the standard compensation type. The unknown voltage is applied across the terminals and the compensating dc voltage is delivered by a dc source. But, in the Czech unit, the sum of the two voltages is amplified and then fed to the cathode ray tube where measured peak value is indicated.

If the compensating voltage is adjusted so that, at the maximum instantaneous value of the measured half wave, the input to the amplifier is zero, the compensating voltage becomes a measure of the peak value of the unknown ac source. Accuracy claimed is better than 0.1%.

Synthetic-rubber adhesive improves panel assemblies

A new neoprene adhesive, unaffected by primers and cleaning compounds and finish-baking temperatures, is reported by DuPont. Used to "spot weld" metal panels, it cures as the finish is baked, helps cushion the assembled unit, and can be applied by automatic methods. The material remains flexible after curing, and has an adhesive strength of about 80 psi. First application is in auto hood assemblies.

Wider use of disk brakes foreseen

Oil-cooled disk brakes may be the ultimate answer to heating problems posed by the increasing severity of braking requirements and the pressure for size reduction, says R. W. Lange of American Brake Shoe.

At the SAE Farm, Construction, and Industrial Machinery Meeting, he suggested, as others have over the past few years (*PE*—Oct 13 '58, p 36) that multiple-disk brakes, already used on crawler tractors, may have to replace alloyed drums and heavy-duty linings on a good many other types of machinery. Oil cooling may not be necessary in all cases, though; forced air cooling should be able to satisfy many requirements. —ARG

WHAT'S HAPPENING IN RESEARCH . . .

Tests confirm strength loss in coated metals

Evidence is piling up that coatings which are supposed to protect metals and enhance their properties may have the reverse effect.

Tests at National Bureau of Standards have already shown (*PE—July 18, p 9*) that organic coatings can markedly decrease the strength of metals to which they are applied.

Fullmer Research Institute in Britain has reported chrome and aluminum on steel may have similar undesirable results (*PE—June 27, p 31*). The coatings do a good job of protecting the metal from oxidation. But the coated metals show a decided lowering of tensile strength, creep resistance and fatigue strength. This is apparently a result of grain growth which occurs at heat-treating temperatures, while the coating is diffusing into the metal. Now, says F. A. G. Liddiard of Fullmer, there is evidence that metal coatings sprayed on aluminum have similar effects.

The latest results, taken in conjunction with the earlier work on steel, strongly suggest, he says, that coatings should be examined critically for possible effects on fatigue resistance, particularly if the parts in question will be subject to high alternating stresses.

Thermistors measure ultralow frequencies

A relatively unrecognized characteristic of thermistors is making it possible to develop filters for very low frequency measurements—for phenomena with periods on the order of minutes rather than seconds.

Thermistors are best known for their temperature-sensitive characteristics (specifically, their negative coefficient of resistance). But, as R. A. Rasmussen of Scripps Institute of Oceanography recently pointed out, these semiconductors also have an apparent inductance that is a measure of the time lag between variations of power dissipation and resultant changes in the thermistor temperature. Apparent inductances on the order of 10^4 h have been measured, he says, and have been resonated with capacitance in VLF circuits.

Tests of ac thermistor characteristics at Scripps show apparent inductance drops vary sharply between frequencies of 0 and 0.1, but then exhibits a slow, even slope extending out to frequencies in the 0.5 range. At 0.05 cps, apparent inductance is 7000 h. At 0.1 cps, it is about 4000 h; and at 0.4, about 1000 h. In resonant circuits, Rasmussen says, the performance curves of the thermistors are very similar to those of ordinary, tuned bandpass filters.

Equations, test circuits, and test results leading to development of the thermistor filters are outlined in *Review of Scientific Instruments*.

Data needed for tractor design

A cooperative, intergroup research program to gather data on fatigue life of vehicle drive components is recommended by A. J. Jenkins, Timken Roller Bearing design engineer.

At the SAE national industrial machinery meeting, he pointed out that, as the horsepower ratings of farm tractors, construction machinery and many other types of equipment have increased, power train components have also been enlarged, with the result that the economical production range is being exceeded—and costs are rising even faster than size.

Now, he suggests, it is time to reexamine the whole question and find out exactly what are the operating characteristics and requirements.

He suggests a new effort to collect data on operational cycles, operational speeds, and related factors—an effort sponsored by equipment builders and administered by the SAE, the Agricultural Experiment Stations, or the colleges.

briefs . . .

To measure ultrahigh-speed reactions, U of California scientists are turning to ultrasonic techniques, taking advantage of the fact that lengths and velocities of sound waves passing through a chemical medium change with changes in chemical reaction time. To do the job, though, UCLA scientists had to devise brand-new techniques because the changes are very small, on the order of 1/2500 in. in length and one cycle/million in velocity; but they can be measured with a technique that combines optical, acoustical, and electronic systems.

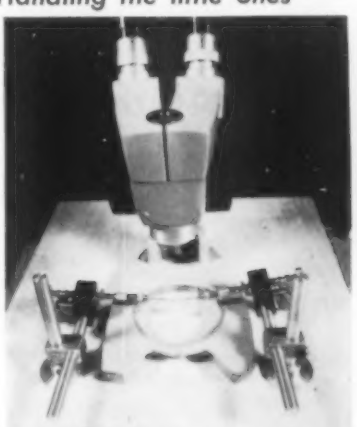
Zirconium alloys with a low, stable corrosion rate in high-temperature water and steam are described in a patent recently issued to J. N. Wanklyn of the United Kingdom Atomic Energy Authority. These are 1 to 5% tantalum alloys to which ½ to 1% by weight of nickel has been added.

The nickel, says Wanklyn, delays considerably the point of "break-away" (the sharp increase in corrosion rate observed at temperatures in a 600-F range), and substantially improves the over-all corrosion resistance of the material.

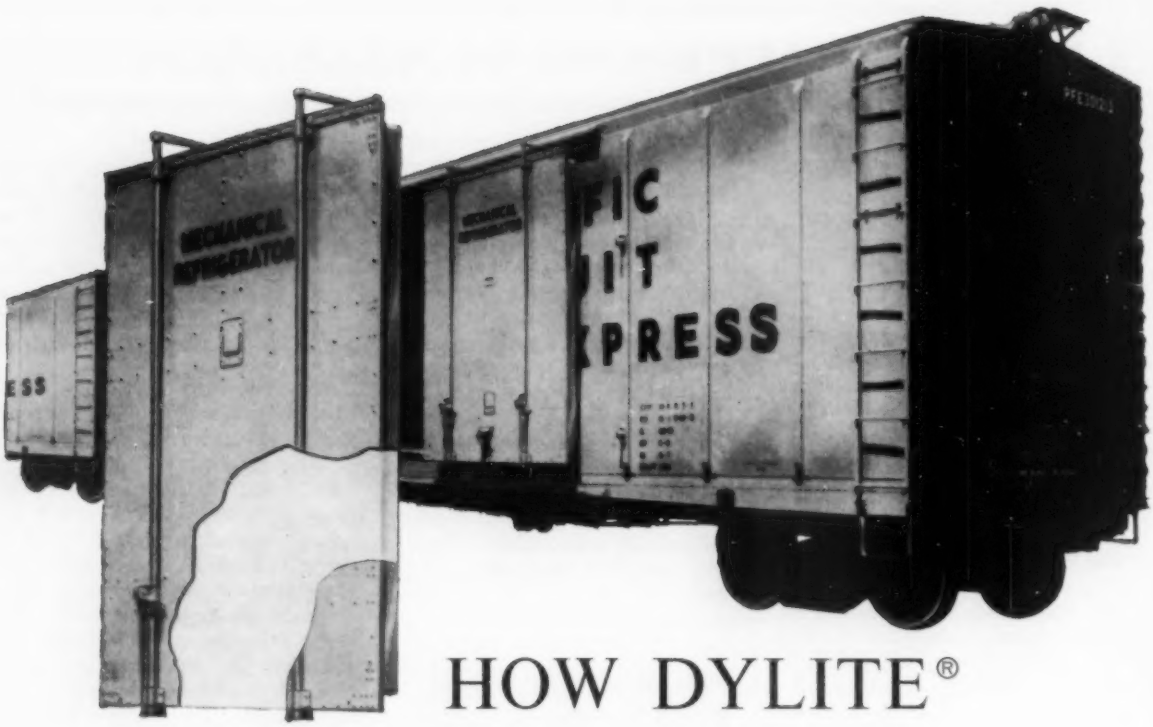
Surprisingly, nickel does not by itself seem to have the ability to reduce the corrosion rate of sponge zirconium. That function is fulfilled by the tantalum. But the nickel, as an addition, does have the power to delay "break-away"—and by a substantial amount.

—ARG

Handling the little ones



TO AID ASSEMBLY and testing of tiny components—particularly semiconductor devices—Micromanipulator Co now offers the probe-tipped units pictured here. Right-hand and left-hand versions are available separately. Price range is $105 to $124, depending on quantity.



HOW DYLITE® GOT ITS FOOT IN A FREIGHT CAR DOOR!

This unique refrigerated freight car door is insulated with DYLITE expandable polystyrene. This lightweight foamed plastic forms a tight, moisture-proof, non-sagging insulation. DYLITE freight car doors improve insulation and weigh 400 to 500 pounds per car set less than conventionally-insulated doors. These doors are now being installed on 1,025 new refrigerated freight cars of the Pacific Fruit Express Company. The cars are temperature-controlled from –10°F to 70°F.

The door liner is molded of CYCOLAC* ABS plastic made by the Marbon Chemical Division of Borg-Warner Corporation. The idea to combine DYLITE with CYCOLAC came from Robert L. Landis, developer and manufacturer of the new door liners which are now manufactured by the Landis Industrial Company, Santa Clara, Calif.

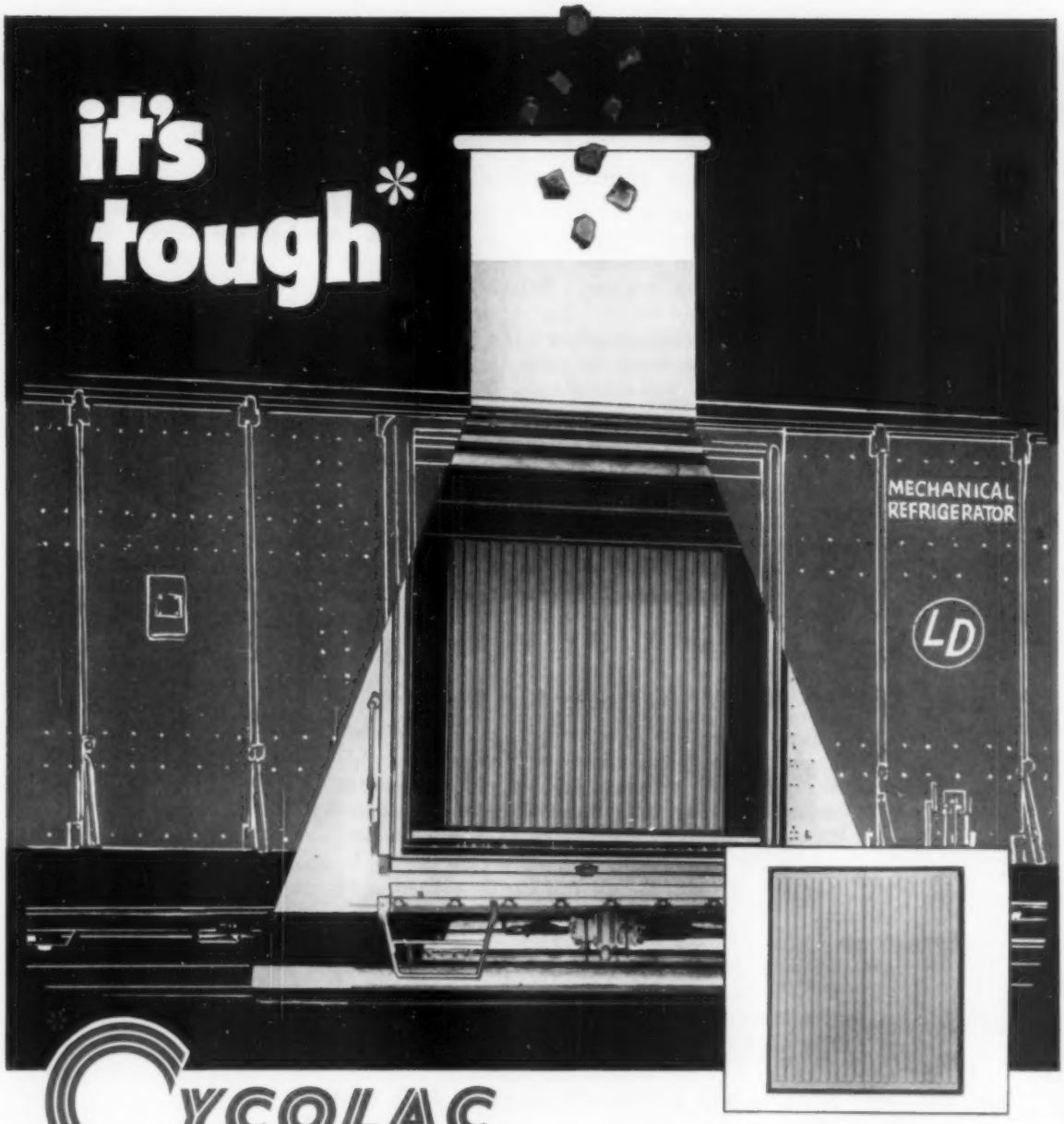
DYLITE comes in the form of tiny crystal beads. When heated, these beads can expand up to 60 times their size and fuse; forming a light, smooth-skinned part at the desired density. DYLITE is a remarkable low temperature insulator having a K factor of 0.242 at 2 lbs./cu. ft. density and a 75°F mean temperature. It is low-cost, non-shrinking, and can be molded to almost any size or shape. In addition, DYLITE is strong, durable, moisture- and vapor-resistant.

For more information on the outstanding insulating qualities of DYLITE expandable polystyrene, write to Koppers Company, Inc., Plastics Division, Dept. PE1030, Pittsburgh 19, Pa.

DYLENE® polystyrene, SUPER DYLAN® high density polyethylene, DYLAN® polyethylene, and EVENGLO® polystyrene are other fine plastics produced by Koppers Company, Inc.

**CYCOLAC is a registered trademark of Borg-Warner Corporation*

KOPPERS PLASTICS



CYCOLAC®

THE BORG-WARNER PLASTIC THAT'S TOUGH, HARD, AND RIGID

Refrigerated car door liners were always made of metal and wood . . . until Landis Industrial Company looked into CYCOLAC. This giant shell made for Pacific Fruit Express by Landis had to withstand impact at sub-zero temperatures and provide excellent moisture resistance. Equally important was weight reduction without sacrifice of strength or durability. CYCOLAC, the tough, hard, rigid ABS plastic from Borg-Warner, delivered the goods on every count! Now, air-tight doors combining CYCOLAC for the inner liner and Dylite® insulating foam made by Koppers Company, Inc., protect frozen food shipments—at a substantial saving. CYCOLAC may be the material you need. Do as Landis did—investigate this remarkable plastic now.

MARBON CHEMICAL MARBON B-W CHEMICAL DIVISION **BORG-WARNER**
WASHINGTON WEST VIRGINIA

FROM WASHINGTON . . .

Military seeks to post stronger guards against satellites

Plans are underway to beef up the US satellite-detection system. Right now, there are two sets, three stations each, stretching across the nation from San Diego, Calif to Ft Stewart, Ga. Each trio has one radar transmitting station located between two receiving stations; covers a 500-mile linear area, but can only detect satellites with any degree of certainty that are below 500-mile-high orbits.

A new high-power transmitter is slated to be installed near Wichita Falls, Tex to plug the gap between the existing stations. It will also be considerably more powerful than the two existing transmitters located at Gila River, Ariz and Jordon Lake, Miss.

The military won't reveal just how much further out it will be able to detect satellites, however. The other transmitters will likely be replaced with more powerful units soon, too.

A north-south satellite detection fence is under consideration. Space experts differ in the need for such a network. The existing east-west fence will theoretically detect any satellite launched above 32 deg north latitude. This covers Russian-launched satellites. However, the detection time of satellites could be reduced by having the additional radar detection fence. This factor, some space experts believe, will justify the added cost of the radar network.

Please move to the rear of the "space bus"

A standard space satellite is being designed by the National Aeronautics and Space Administration (NASA). It will be another year or so before this satellite (dubbed the "space bus") is developed, however. **Purpose of the plan is to standardize all equipment necessary to get the satellite into orbit and feed back information.** Then, NASA says, a wide variety of scientific experiments can be installed in the satellite without the necessity of tailor-making each satellite for specific experiment, as is done now. **Reuse of the standard satellite equipment will ensure reliability, NASA says.**

Payloads for the satellite will run up to a ton or so. **NASA officials say the "standard" satellite will enable it to cut time and expense in space experiments, and also allow conducting them on somewhat of a production-line basis.** As scientists come up with needed experiments these will be pooled with other experiments carried in the satellite.

Nixon proposes strategically scattered federal R & D centers

A series of small, federally financed research centers spread around the country has been proposed by Vice-Pres Nixon. The plan was made recently in a "position paper" on science and technology by the Republican presidential candidate.

Basic research unhampered by collateral teaching and other duties is the key to Nixon's plan. The centers would be coordinated with existing university research programs, yet retain sufficient autonomy to ensure research freedom. State and industry would match federal funds under the Nixon plan.

Admittedly broad in scope, without firm recommendations on how many centers to establish or matching fund ratios, **the plan has won wide acclaim from scientists.**

Speculation is that rival presidential candidate Kennedy may counter Nixon's plan with a proposal to establish a Cabinet office of science and technology.

Unofficially, the National Science Foundation reportedly wants to increase its basic research support to around $250 million a year. Right now, it only spends some $60 million to $70 million in this area. Currently, NSF officials say, because of lack of money they must reject 50% of research proposals that show merit. The agency is enthusiastic over the Nixon proposal.

CIRCLE 13 ON READER SERVICE CARD→

(What's wrong with this picture?)

Are your "dead storage" files more efficient than your active drafting files?

No doubt about it—it's very important to keep correspondence carefully and safely filed; *but* certainly as important to equip your drafting department with modern filing facilities that keep your active and semiactive drawings totally accessible—in a minimum of space—and protect them fully.

Your draftsmen, your productivity, deserve new Hamilton space-and-time-saving equipment—from Bruning

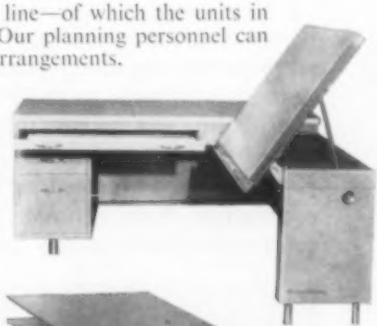
The equipment in your drafting room, perhaps more than any other equipment you have, helps determine total productivity through the practical creativity of your engineer-draftsmen. Because Hamilton equipment *is* engineered to deliver maximum savings in time and space—it is basic to accuracy, motion economy, lessened fatigue—functional and human factors that determine total efficiency.

Inadequate or antiquated equipment in your drafting room can't help but cost you money, foster errors, as well as cumulative losses.

Hamilton design is basic, practical—thoroughly tested in many thousands of installations. Its rugged construction delivers many, many years of consistent performance.

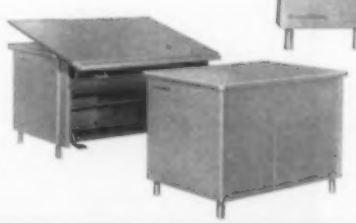
We feature and service the *full* Hamilton line—of which the units in this advertisement are only a small part. Our planning personnel can give you valuable help to determine best arrangements.

The Hamilton L-Contour Table
A personalized work area concept permitting a wide range of board adjustments, from horizontal to vertical, yet provides considerable storage area and occupies small space. Single support torque tube tilt mechanism provides stable, perfect balance of the durable, seasoned working surface.



Hamilton Plan Files
The Hamilton unit system offers maximum protection and capacity in minimal space. For instance, each drawer of any of our patented shallow drawer units is equipped with a tracing lifting mechanism . . . every tracing becomes a top sheet, instantly accessible. Unit sections can be assembled in a number of arrangements, stacked safely to any practical height. They stand up to hard usage, perform perfectly year after year.

Hamilton De Luxe Auto-Shift Table
Completely functional features combined with modern styling, to create exceptional efficiency. Because this table sharply reduces fatigue, it helps you achieve highest quality and peak production. Fully seasoned drawing surface, adjustable to individual height and slope requirements. Quick, easy adjustments. Many features, creating ideal conditions for each individual job. Exceptionally durable, handsome in appearance.



Put draftsmen in a "position" to do better, faster work!

Bruning's all-new Neoglide drafters literally help draftsmen straighten up and do faster, better work.* They provide complete maneuverability on any board at any angle without adjustment! Reinforced U-beam construction assures rigidity, strength, and accuracy. Resistance-free movement of vertical beam and hidden counterweight provide fast "floating" action. Touch-control protractor head gives automatic, pinpoint angle selection.

*Study of 300 draftsmen showed 35% savings in drawing time—1/5 the backaches—on vertical or near vertical boards.

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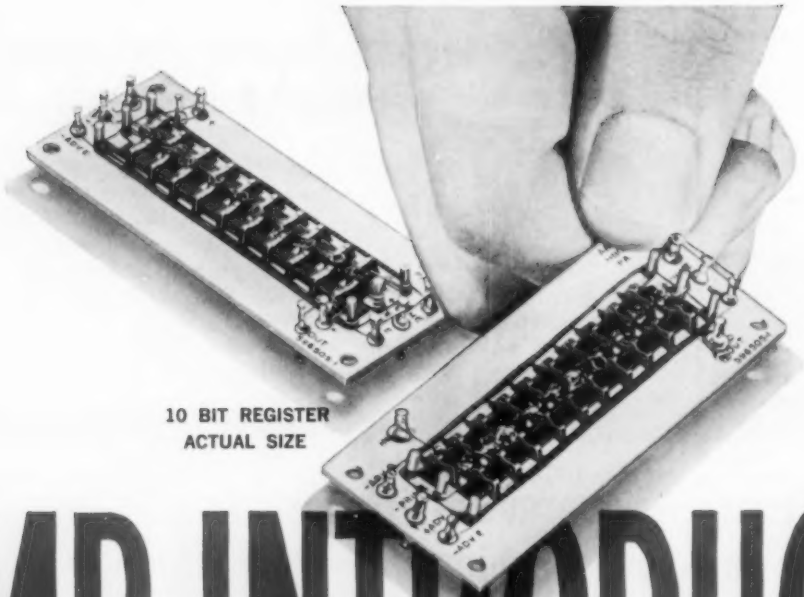


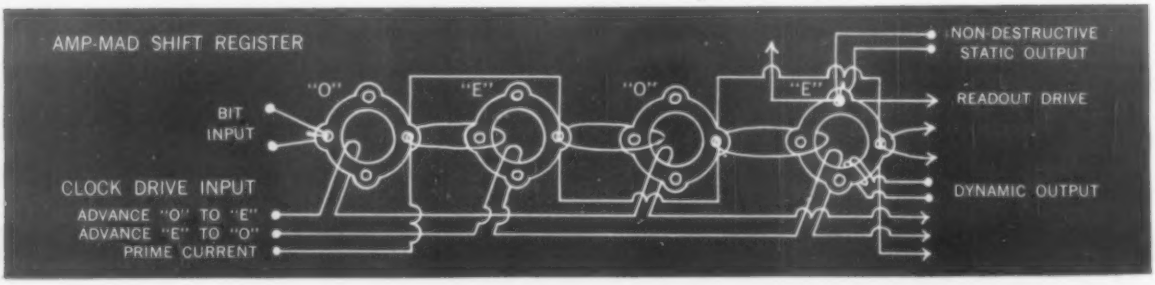
10 BIT REGISTER
ACTUAL SIZE

AMP INTRODUCES

A COMPLETELY NEW KIND OF SHIFT REGISTER USING MAGNETIC ELEMENTS ONLY...

Here is the first commercially available line of all-magnetic shift registers. Now you can have both non-destructive dynamic and static output in the same register. Now you can have the minimum number of components, the minimum number bit to bit interconnections and any serial/parallel input and output combination. Made with AMP multiaperture ferrite cores and copper wire only (see schematic below), the AMP Shift Register line has a number of other useful features:

- —40°C to +75°C temperature operating range
- minor aperture output level up to 100 mw at several volts
- immune to nuclear radiation
- small size—ideal for miniaturization requirements
- ultimate in reliability and simplification



For complete information, including operating data, send for our AMP-MAD Shift Register brochure.*

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THE ENGINEERING WEEK

Speedup Seen in Salt-water-conversion Program

WASHINGTON—Progress on developing an economical way of producing fresh water from the seas has been so rapid during recent months that government experts hope for considerable expansion in the program (*PE*—Oct 26 '59, *p* 33) during the next few years. The fruits of early research are now being turned into operating demonstration plants, and the government expects to step up research and development of the most promising.

With the original $10-million authorization nearly exhausted, the Administration expects to ask for greatly increased funds for the next few years. Next year's anticipated appropriation of about $1.7 million will leave only $700,000 for the final year.

But the Interior Dept Offices of Saline Water, with Administration backing, will ask the next session of Congress to authorize $20 million for 1961-65. It will be marked for economic surveys of areas that would benefit from desalting, badly needed studies to determine costs of developing new fresh water sources vs desalting plants, and federal loans to community construction of saline plants as well as further saline research. Such a bill was introduced this year by Sen Lyndon Johnson, but passed the Senate too late to give the House time to hold hearings.

MOST PROMINENT PROPOSALS

Most of the excitement among government experts centers around the different freezing processes. Freezing has a big theoretical advantage over heating: it takes less energy to turn water into ice crystals than into steam. Where fuel is expensive, this is particularly important. Freezing also presents fewer corrosion problems; sea water corrodes less easily at low temperatures than at high. The problem of scale formation in distillation plants is also avoided. However, conversion by heat may still prove out, based on a multistage flash evaporator unit recently installed by Cleaver-Brooks in a Southern California Edison steam-electric plant.

The freezing-demonstration plant will most likely use a system developed by Carrier Corp, Syracuse, NY, because it is furthest along at the moment. This system uses flash evaporation in which precooled water is sprayed into a partial vacuum, forming a slush. The ice rises to the top, is washed free of salt, and melted again by the heat of incoming sea water. A pilot plant is operating at Wrightsville Beach, NC.

Cornell Univ has developed a process in which a secondary refrigerant such as butane gas is introduced into sea water. The slush formed is washed in a roto-cell. A 35,000-gal.-per-day pilot plant is being built at St Petersburg, Fla by Blaw-Knox Co of Pittsburgh to test the system.

Scientific Design Co Inc of New York City has developed a third freezing process, involving "controlled crystal growth" which produces larger crystals and therefore makes an easier washing job. It also introduces a secondary refrigerant and the large crystals are washed in a centrifuge. The Office of Saline Water is negotiating with Struther-Wells Corp, Warren, Penna, to build a pilot plant.

Further experimental work is going on also to improve the long-tube-vertical distillation process. W L Badger & Associates is testing a new way to control calcium phosphate scale by injecting into the sea water a slurry which chemically attracts the scale particles and can be separated out. Results are "very encouraging" at this point. If it works, the temperature at which scale forms could be raised from 250 F to 300 F. This would enable the Freeport, Tex plant (see chart) to produce 1.6 million gal. daily instead of 1 million, and cut costs from about $1 per thousand gal. to 80¢.

Different types of plastic membranes for the electrodialysis process are being tested at the Bureau of Reclamation in Denver with a pilot plant of Ionics Inc of Waltham, Mass. Ionics is expected to bid on construction of the brackish-water plant for South Dakota. (*PE*—Oct 13 '58, *p* 39).

Another new process in the experi-

Desalting Projects Underway

Process	Plant Size, Cost	Site	Architect & Eng. Firm	Construction Contract	Remarks
Long-tube-vertical, multiple-effect distillation	1 million gal. per day; $1.2 million	Freeport, Tex	W L Badger & Assoc	Chicago Bridge & Iron Co	To be in operation March 1961 — sea water
Multistage flash distillation	1 million gal. per day; $1.5 million	San Diego, Calif	Fluor Corp	Bids to be opened Oct 18	To be in operation Nov 1961 — sea water
Electrodialysis	250,000 gal. per day; $.5 million	Webster, SD	Bureau of Reclamation, Denver	Bids to be opened Oct 4	To be in operation Aug 1961 — brackish water
Forced-circulation vapor compression	at least 250,000 gal. per day	Roswell, NM	Not picked yet	No date set	Brackish water; experimental work completed
Freezing	150,000 to 350,000 gal. per day	East Coast	Not picked yet	No date set	Sea water; 3 processes being tested in pilot plants

mental stage is use of hydrated gas. Gas particles attract fresh water, a slurry is formed and washed, and the gas-water crystals are broken down and the gas reused. Koppers Co of Pittsburgh has the contract. Solar stills are also being tested at Daytona Beach with potential for desert-type areas where land is cheap and sun is plentiful.

Besides the several approaches being sponsored by the Office of Saline Water, there are scores of proposals submitted by US overseas companies and individuals. This steady stream of ideas is channeled to the Interior Dept and evaluated for funding.

Typical is a recent proposal by a Chance Vought nuclear physicist. His method calls for utilizing radioisotope energy to boil salt water. Steam emitted is captured as fresh water as it condenses, leaving a salt sludge in the "bed heater." CV says use of radioisotopes is safe because fission products carrying the radioisotopes are placed in capsules which allow harmless beta and gamma rays to escape into the continuously flowing water. These rays transfer their energy to the water, causing heat, then boiling. Other radiation is dissipated in the water. Feasibility of the CV proposal is still being studied.

—David Secrest—Washington Bureau

Radar Device Cuts Noise

DALLAS—A radar device that sorts target pulses from noise and interference has been laboratory- and flight-tested by the Electronics Div of Chance Vought. Called a "video correlator," it is expected to increase effectiveness of radar for aircraft, ships or land bases.

Key elements of the device are two matched magnetostrictive delay lines and their associated coincidence gates. Vought says all characteristics of the raw video signal are retained without distortion.

Because target pulses are received at uniform time intervals, and noise and interference are either irregular or occur at different time spacings, the correlator, using a delay principle, selects only those signals which come from the target.

The device can be tailored for any existing radar. Vought electronics reports it has received a Navy contract to supply models for evaluation. ■

Parade of 1961 Models Continues

THE 1961 PLYMOUTH will be the first model in years without fins. Length and height of the car remain the same but width is 80 in. Wheelbase is 118 in. Five engines are available, from 145 to 330 hp. The top performer has a 383-cu. in. displacement with two four-barrel carburetors. As with all Chrysler cars this year, an alternator replaces the old-style generator. There is also a new distributor with a nylon rubbing block which resists bouncing and reduces need for adjustment.

THIS IS DODGE DART'S second year. It is now one inch shorter and one inch wider, giving it a width of 78.7 and length of 209.4 in. Wheelbase is 118 in. A new ram-induction V-8 turns out 330 hp at 4800 rpm. Compression ratio is 10:1 and equipment on the engine includes two 4-barrel carburetors, dual exhaust, a special camshaft and spring valve dampers. Compression ratio of the Slant Six has been reduced from 8.5 to 8.2 and an 8-deg advance in camshaft timing should make the engine less noisy.

DE SOTO LINE has been reduced to one series with only two models, a 4-door hardtop and a 2-door hardtop. The car is basically the same as last year's with a 122-in. wheelbase and 79.4-in. width. One standard 361-cu. in., V-8 is available, designed to operate on regular-grade gasoline. Compression ratio has been lowered from 10:1 to 9:1 and intake valves have been enlarged to improve efficiency. Bore is 4.12, with a 3.38 in. stroke. Declining sales indicate this is the crucial year

THE POLARA IS DODGE'S ENTRY in the medium-price field. Buyers will have a choice of three engines ranging from 265 to 330 hp. Using regular gasoline, the 265 V-8 is standard with a displacement of 361 cubic in. New engineering features include: a solenoid-shift starter, a heavy-duty manual 3-speed transmission, 3-phase ac generator, and new tires which Dodge claims give 15% more mileage per tire. Ram induction is also available. Over-all length is 212.4 in. Wheelbase is still 122 in.

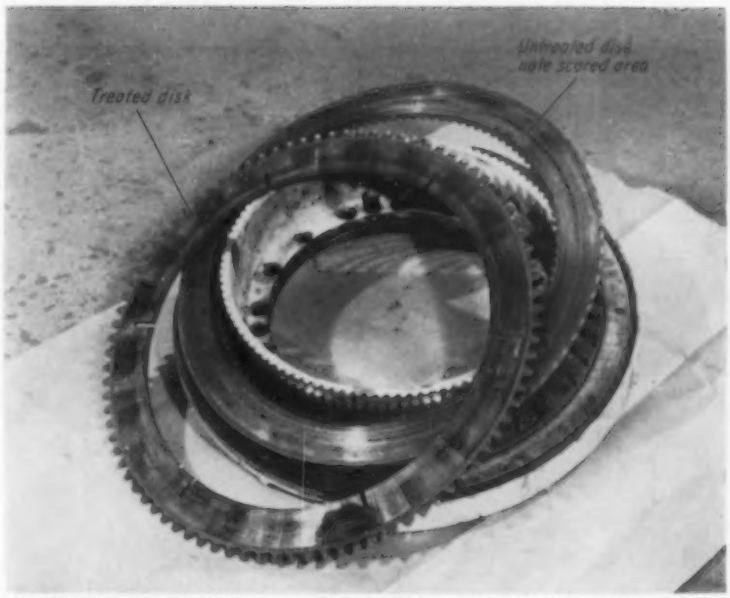
Same Dry Lubricant Solves 3 Brake Problems

PEORIA, ILL.—Molybdenum disulphide is the answer found by LeTourneau-Westinghouse for a trio of problems with the brakes on heavy-duty equipment. This dry lubricant has lengthened brake life, reduced wear, and improved efficiency of the brakes.

It extended life by serving as a rust-preventive. The rust comes after sweating caused by temperature changes, and forms a film on brake drum disks, both in the operating brake and on parts in storage. A spray lacquer will protect stored parts but cannot be used on an operational brake. Coating and baking a film of molydisulphide on the brake prevents deterioration due to rust, both before and during operation.

Uneven wear was the second problem facing LeTourneau-Westinghouse. Brake disks scored and galled for no apparent reason. The type of metal made little difference; also, the same disk might wear normally on one side and score on the other. A film of molydisulphide particles was found successful in combating surface wear during initial break-in.

Mechanical malfunction was the other problem. The brake itself is made up of a series of alternating disks: some, with internal teeth, are stationery; the others, with external teeth, rotate with the wheel. The disks fit into the wheel's hub. During braking, a large diaphragm squeezes the disks together, creating friction needed to stop the vehicle. When air is released, the disks separate, making it possible for the wheel to turn freely.



DISASSEMBLED BRAKE shows disk in foreground, treated with molydisulphide, has worn evenly. Untreated disk behind it reveals galling and scoring. Seven such disks are used in complete assembly.

For some reason, the teeth of the disks would jam in the hub, either preventing braking action or greatly increasing drag and wear. With the dry lubricant, even at temperatures around 1000 F, this "hang-up" during operation was eliminated—a sufficiently slippery surface is provided throughout the braking cycle.

Though the major problems have been solved, LeTourneau-Westinghouse is continuing research on solid lubricants in an effort to reduce cost. ■

New Forms of Lexan Promise Unusual Properties

MOUNT VERNON, IND—General Electric is readying a new plant here to produce its polycarbonate resin, Lexan (*PE*—Sep 29 '58, p 36). The large-scale production, 5 million lb per year, should lower price to a more competitive 60¢ to 85¢ per pound from the present $1.50, according to GE engineers. Production of commercial quantities will culminate five years of development of this strong thermoplastic offering heat-distortion temperature and excellent impact resistance. Some high points of current development effort on polycarbonates include:

- A copolymer film with better resistance to solvents than Lexan and even greater high-temperature strength.
- A crystallized form of Lexan—usually only 10 to 20% crystalline. Samples of film that have monoaxially oriented crystals exhibit ultimate tensile strengths from 20,000 to 40,000 psi, compared with 10,000 psi for ordinary Lexan.
- Polycarbonate elastomer. In sheets, this elastomer shows high tear strength.
- Fabrication techniques. Lexan, with metal-like ductility, can be cold-worked by equipment ordinarily used for brass, aluminum or copper. Some difficulties arise when using it in the fluidized-bed process. At the usual fluidizing temperatures, Lexan is so viscous that instead of flowing into a perfectly smooth coating, bumps are left.

Apparently it is possible to get too much of a good thing in a material. Under Army tests Lexan proves excellent for stopping bullets, but attempts to make it even better with glass reinforcement failed. Lexan adheres so well to the glass that the fibers cannot tear out, which is how they absorb energy. Now a way must be found to give less adhesion.

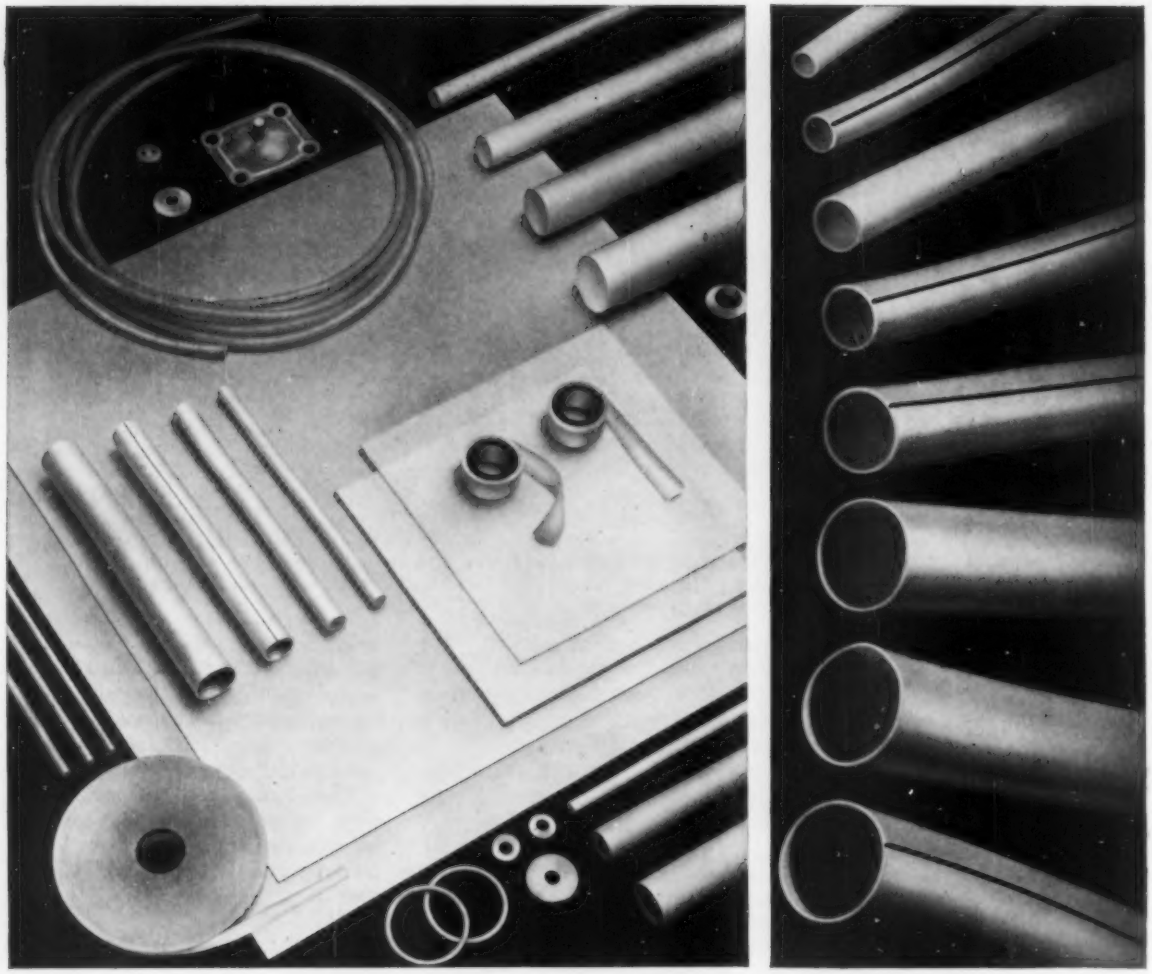
—Bruce Frisch

French Official Promises Hike in Applied Research

LYON, FRANCE—Progressive budget boosts are expected to push French government research to double the 1958 level by 1962. The projected increase in government research was described by Pierre Piganoil, top research man in the DeGaulle govern-

continued on page 20

Designers think of R/M first for asbestos, rubber,



R/M tubes, rods, sheets, tape, thin-wall tubing and new color-coded thin-wall tubing

How R/M TEFLON* capabilities cut design costs

The cost of designing with "Teflon" is directly related to the capabilities of your "Teflon" source. Here is how the proved knowledge and complete service of R/M can help you make your "Teflon" dollars work harder.

Production facilities to handle all your "Teflon" requirements . . . in standard or special sizes and shapes . . . in any quantity you need.

Engineering assistance on the spot to help you simplify parts, improve performance, minimize fabrication by designing with a stock size and shape, or make use of a more efficient fabrication method.

"Teflon" research in application and fabrication brings you a constant flow of new "Teflon" products. Color-striped thin-wall tubing, square convolution expansion joints, bondable "Teflon" and 1/32-in.-thick 36 in. x 36 in. sheets are recent examples. If you have a special application, R/M engineers are ready to assist.

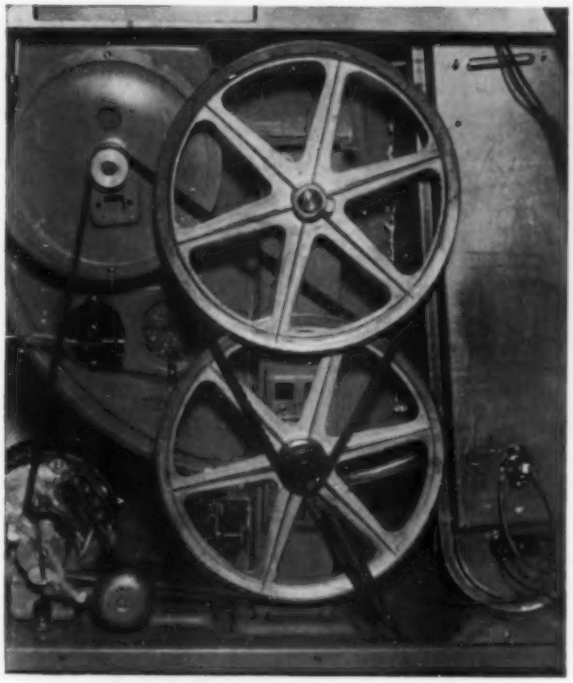
Authoritative product information, which only an industry leader can provide so well, is available to you from your nearby R/M district office . . . or write Plastic Products Division, Raybestos-Manhattan, Inc., Manheim, Pa.

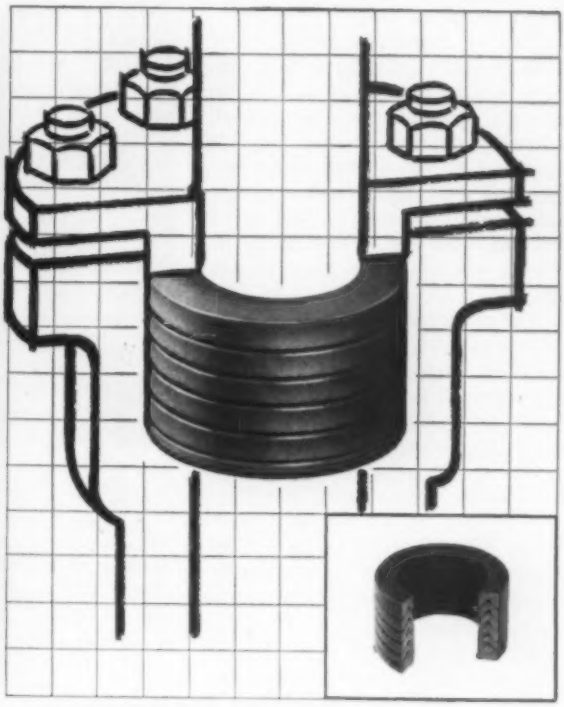
*A DuPont trademark

PLASTICS

Ask for a copy of this booklet on the complete R/M line of "Teflon" Products.

sintered metal, and engineered plastic products





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Outlasts Other Belts 8-1

The Only Belt of its Kind . . .
Fully Molded, Completely Jacketed Notched V-Belt

Ideal for small sheave diameters, short centers, high speeds

Micro-positioned strength member is supported in a "Power Arch" and locked into a homogeneous molded unit for perfect balance, cool, quiet, *vibrationless* operation. Locked-in length stability. Fully covered; prevents flex-cracking; maintains shape. Completely protected from atmospheric conditions; no ply separation; less wear on grooves. Let R/M rubber specialists work with you on V-belts, transmission or conveyor belting, rubber hose, molded or extruded parts.

R/M CAPABILITY

develops industry's most effective packings—
R/M Vee-Flex® Packing Rings and Fabric Piston Cups

R/M Vee-Flex Packing Rings and R/M Fabric Piston Cups are both examples of the ability to produce outstanding packings for hydraulic and pneumatic applications.

R/M Vee-Flex Rings are self-adjusting and self-sealing; are designed so that pressure automatically expands the lip on the pressure stroke, forming a tight seal against the stuffing box wall and shaft. On the return stroke, the ring assumes a relaxed position, thus reducing wear.

R/M Fabric Piston Cups are designed for minimum friction, highest resistance to extrusion, and positive sealing action. Uniform dimensions, clearly defined contours, and cleanly trimmed edges are characteristics. Both duck and synthetics and asbestos and synthetics are available.

R/M's vast experience in design, compounding and manufacturing of mechanical packings and gasket materials is at your disposal.

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Write today for free booklet shown: full details on a wide variety of industrial rubber products. Manhattan Rubber Division, Raybestos-Manhattan, Inc., Passaic, N.J.

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R/M

CIRCLE 204 ON READER SERVICE CARD

continued from page 17

ment, at a meeting of some 450 research executives here.

Piganoil pegged the government's 1960 effort at $200 million. Next year he promised a $20-million increase. In addition, $60 million will be allocated next year for a supplementary program scheduled to run 5 years. This program will attack sectors such as energy conversion, oceanography, and space research, considered soft spots in French research by a team of top scientists.

The government is also considering a national center to serve as collecting point for scientific information. The center would be equipped with extensive data-handling and storage equipment, which could provide researchers with a record of work already done in their particular area.

Theme of the two-day meeting at which Piganoil presided, was applied research with emphasis on problems of small- and medium-size companies. Even a very small company, Piganoil said, needs liaison between management and technical developments. Contract research, a rarity in France today, is one possibility for companies with small budgets, he said.

Scene of the meeting was the Institute National des Sciences Appliques (INSA), where a large engineering-science training and research center is being built. INSA already has 1700 students and will have classrooms and labs for 4000 by 1965. Located in a concentration of technical facilities, the INSA campus is neighbored by the University of Lyon, whose science faculty will be training upwards of 10,000 students by 1965. Also under development nearby is an industrial contract research center, a private corporation set up by a group of Lyon companies. It will tap INSA, the university faculty of science, and other technical facilities in the area.

—Art Erikson, Paris Bureau

Machine-tool Buying Expected to Improve

CHICAGO—The buying doldrums in the machine-tool industry may be over if the optimism of machine-tool builders at the Chicago exposition is taken as a criterion. Many exhibitors reported active interest—with price quotations sought—for both new and older machines.

Although order-taking on the exposition floor was not permitted, several companies sold all exhibited machines within the two-week period. Orders were placed with the home office for machine delivery from Chicago.

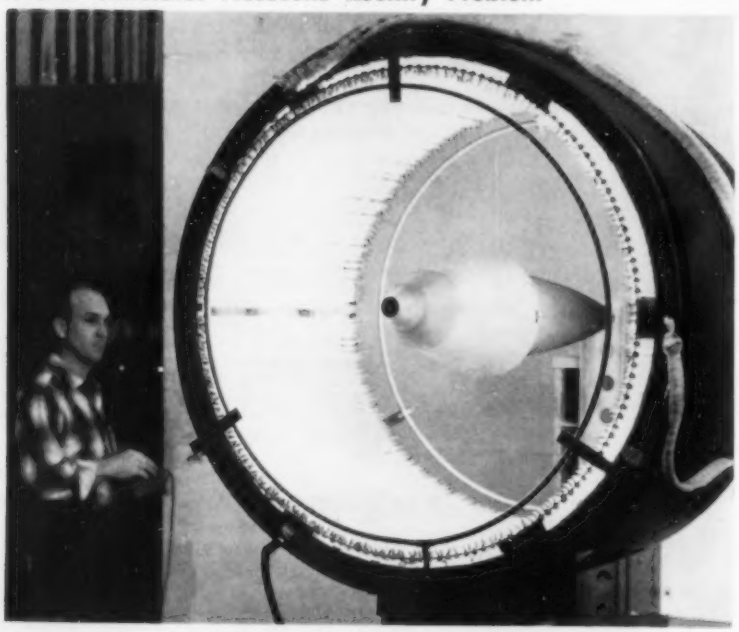
And if the quality of the buyers roaming the vast show was any indication, many tentative orders should be firm by the end of the year. Overall attendance, less than in 1955, had many more purchasing agents, plant engineers, and supervisory personnel. These are the men, said one exhibitor, who place the orders or have a direct effect on which machine is to be purchased.

PRICES UP, SALES UP

The fact that many companies had just boosted prices didn't deter buyers. Price increases range from 4 to 15%, and although many admit this is not the time to increase prices, component costs are forcing the upward spiral. One company cut its prices effective Oct 1. General Electric, citing higher sales which permit lower costs, has cut its price of numerical-control equipment by 10%. Other control companies are holding prices or upping costs slightly. Here, price is not the important factor; sales often depend on adapting the right control to a machine. Some 50 manufacturers showed tape-controlled machines, compared with only 3 organizations exhibiting in 1955.

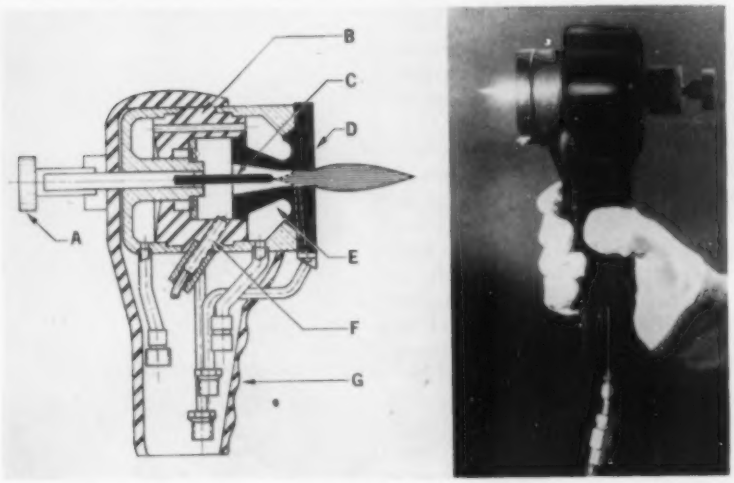
Operating experiences with numerical-control machines were reported excellent by users at a Society of Automotive Engineers (SAE) seminar. Many companies reported that one NC machine can replace three conventional units, and one buyer mentioned a 15:1 figure. Savings ran from a few hundred dollars to $15,000 where intricate tooling was required. Although certain of the newer machine tools can be retrofitted with numerical-control, the panel didn't recommend this. ■

Heater Simulates Nosecone Reentry Problem



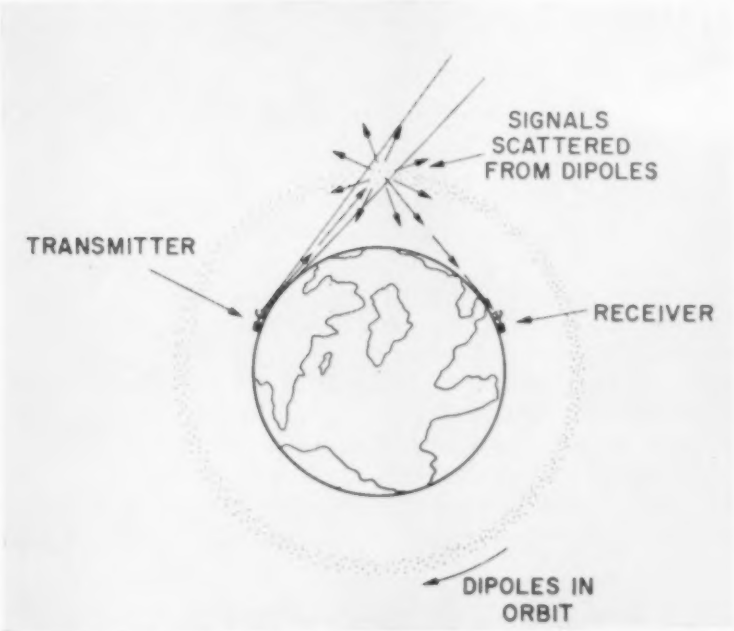
Thermal-barrier temperatures are simulated in this nosecone test at the NASA's Langley Research Center in Virginia. Such tests help the nation overcome reentry problems in rocket missile and space-vehicle programs. Heat produced by 225 2500-watt, pencil-thin, tubular infrared quartz lamps made by General Electric reaches 3100 F in the cylindrical radiator. This is about 1/3 as hot as the sun's surface. Max wattage a quartz lamp can withstand is about 6100 F, the melting point of the tungsten filament. Lamps designed for 200 watts per inch are now in use and some, for 360 watts per inch, are under development. New platinum lead-in wires are featured for long life in the lamps, which are available in 8 sizes from 500 to 5000 watts.

Wide Temperature Range Possible with Plasma Spray Gun



Any standard Plasmatron SG-1 hand-held plasma spray gun can now be modified to permit variable arc temperatures. This is done with a kit made by the Plasmadyne Corp, Santa Ana, Calif, which allows jet temperature to range between 300 F and 30,000 F. Electrode (C) is mounted in an adjustable rod (A). Distance that the electrode projects into throat of the front electrode (D) regulates the temperature. The closer the arc, the higher the temperature. Material to be deposited is injected into the arc through a tube (F). All connections are made through the handle (G).

Metal Belts for Global Radio System



Use of reflective properties of a belt of tiny metal fibers, or dipoles, may provide the means for a future global communication system. According to W. E. Morrow Jr of MIT's Lincoln Laboratory, millions of these orbiting particles—each ½-in. long and one-third the diameter of a human hair—might be ejected into space by rocket with each dipole being separated by a distance of about 1000 ft. With two belts of dipoles—one east-west over the equator and one north-south over the poles—Morrow says communications could be established between any two points on earth. All of the system's active radio equipment would be located on the ground for easy maintenance and high reliability.

Export-import Deal Brings Soviet Translations from Israel

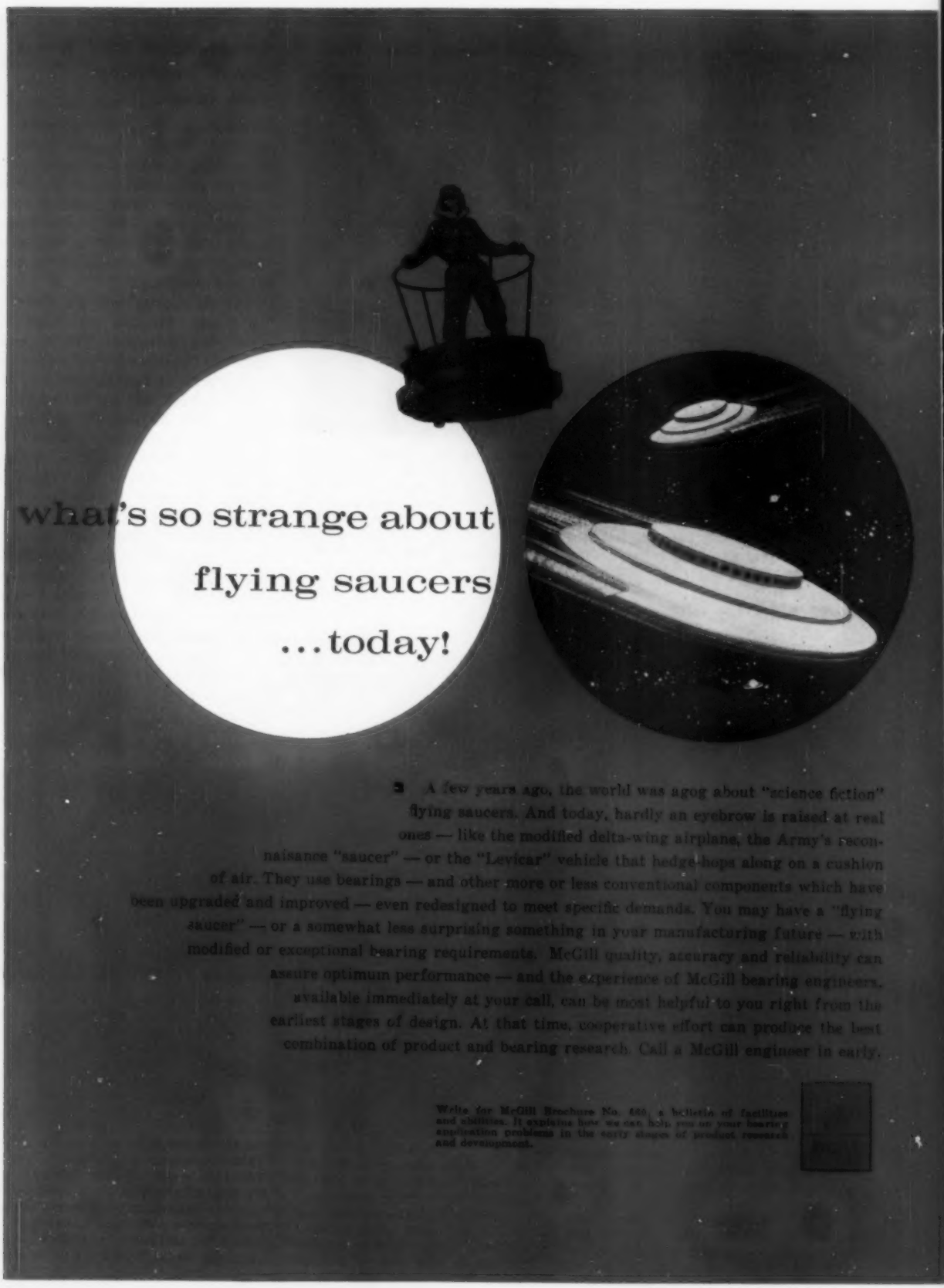
WASHINGTON—Delivery of the first Russian scientific technical publications to be translated abroad as part of a US farm-relief program has been announced by the National Science Foundation and the US Dept of Commerce. The program is financed through export of surplus agricultural commodities.

The translations were prepared by the Israeli Program for Scientific Translations, Jerusalem. This program calls for translating and printing 50,000 pages of Russian material. Another program, this one by the Central Institute for Scientific and Technical Documentation, Warsaw, is translating 19,000 pages of Polish technical works, and the Yugoslav Federal Executive Council is translating 20,000 pages of Serb-Crotian.

Translation funds have accrued under provisions of the Agricultural Trade Development and Assistance Act of 1954, which permits foreign countries to purchase US farm surpluses with their local currencies. The US is obligated to spend proceeds in the purchasing country. ■

Low-speed Fan Cools Electronic Gear Quietly

A low-speed, axial-flow fan which cools electronic gear at an unusually low noise level has been developed by Garrett Corp's AiResearch Div. The fan measures 5.62 in. dia, 10 in. long; weighs 12 lb; turns at 3375 rpm. Its three aerodynamic stages obtain a static-pressure rise of 3.2 in. of water at a flow rate of 120 cu ft/min, with sea level pressure at the fan inlet. This performance, delivered at a wheel tip speed of 81 fps, results from use of relatively high blade-loading factors. Fan has a 2-pole motor which operates with a 60-cycle, 3-phase power supply of 115/200 v, and draws 0.60 amps per phase.



A few years ago, the world was agog about "science fiction" flying saucers. And today, hardly an eyebrow is raised at real ones — like the modified delta-wing airplane, the Army's reconnaisance "saucer" — or the "Levicar" vehicle that hedge-hops along on a cushion of air. They use bearings — and other more or less conventional components which have been upgraded and improved — even redesigned to meet specific demands. You may have a "flying saucer" — or a somewhat less surprising something in your manufacturing future — with modified or exceptional bearing requirements. McGill quality, accuracy and reliability can assure optimum performance — and the experience of McGill bearing engineers, available immediately at your call, can be most helpful to you right from the earliest stages of design. At that time, cooperative effort can produce the best combination of product and bearing research. Call a McGill engineer in early.

Write for McGill Brochure No. 440, a bulletin of facilities and abilities. It explains how we can help you on your bearing application problems in the early stages of product research and development.

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HEAVY DUTY
NEEDLE ROLLER
BEARING

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INCREASE EXPECTED LIFE UP TO 10 TIMES!

You need CAGEROL bearing performance if higher speeds and increased misalignment have prevented the utilization of needle bearing load capacity in your applications. Most important, CAGEROL bearings can deliver up to 10 times more expected life where misalignment and increased speeds exceed the capabilities of ordinary and guided needle bearings. The difference is in the exclusive McGill construction that features tapered retainer pockets for balanced roller guidance, crowned rollers, and black oxide retainer finish. CAGEROL bearings are interchangeable with all heavy duty needle roller bearings — with or without inners in two bore sizes.

McGILL MANUFACTURING CO., INC., Bearing Division
201 N. Lafayette Street, Valparaiso, Indiana

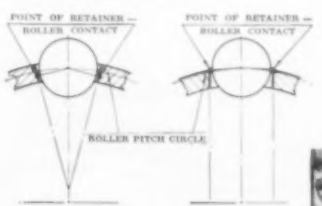
1 Exclusive crowned roller construction, electronically gauged to insure precision contour and size uniformity. Relieved ends assure even load distribution.

2 Flat ends fully engage integral race shoulders, provide maximum support.

3 Proper guidance assured by tapered retainer pockets. The design insures *balanced* roller support and eliminates corner wear from edge loading of straight pockets where retainer OD and pitch circle are coincident.

4 Simultaneously punched pockets assure accuracy of race and roller alignment. The black ferrous oxide retainer finish absorbs and retains lubrication, reducing the friction coefficient.

5 SAE 52100 steel outer race has optimum hardness and surface finish.



Ask for Bearing Catalog #52-A.

engineered electrical products

McGILL®

precision needle roller bearings

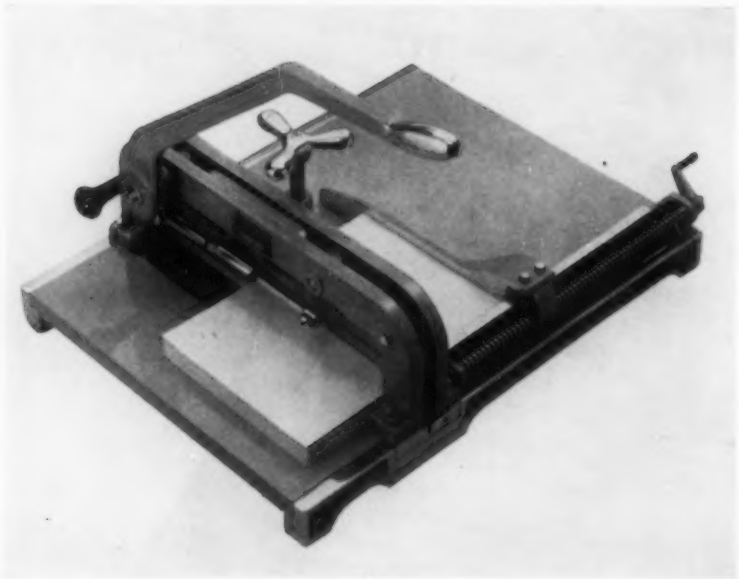
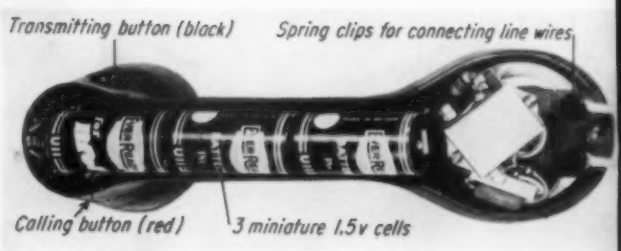


TABLE-TOP PAPER CUTTER is devoid of trim and decoration, yet achieves functionally attractive look of a tool because of the way the strong shape of the frame supporting guillotine-type blade is repeated in lever, base and other large components. Note how this shape adds to compactness when handle is in lowered, inoperative position. Cuts more than 300 sheets (up to 14½-in. width) at once. Made by Douglas Homs Co, Burlingame, Calif.

PORTABLE PHONE packs its own three-battery power supply and can be connected to transmission line anywhere within 9½-mile range. Housing is neatly proportioned and looks comfortable to hold, but connectors sturdier than the spring clips used here would probably be preferable for this kind of service—especially if mounted on exterior of completely closed housing. Made by Standard Elektrik Lorenz AG, West Germany.



GAUSSMETER indicates direction and measures magnitude of magnetic-flux density in magnetic tape, meters, vibration pickups, magnets, dc motors, etc. By using meter that has zero positioned at center, direct reading of direction of magnetic flux is provided—normally, reversing switch would be used, with consequent danger of misreading. Making hollow carrying handle also serve as a protective receptacle for probe when device is not in use is good idea, but better integration of forms here would have made for a more secure receptacle. Developed by F W Bell Inc, Columbus, Ohio.

THE PRODUCT ENGINEER, THE INDUSTRIAL DESIGNER —AND THE PROBLEM OF MATERIALS SELECTION

MONTGOMERY FERAR, Sundberg-Ferar Royal Oak, Mich

■ Engineers tend to be traditionalists when it comes to materials. In the first place, they usually select materials and finishes on technical and economic grounds alone. Understandably, they do not like to take chances on materials with which they have not had experience; and usually they do not have enough lead time to conduct field tests of the material before specifying it.

The newer plastics offer an example of unwillingness to take chances. In the past, many plastics failed through improper application. Your product engineer is aware of this. He is not as aware of the fact that the plastics industry has made enormous strides during the past five years toward overcoming the drawbacks of earlier materials. The engineer doesn't fully realize that the industry can now, in effect, formulate a material for a specific application.

The same situation occurs to some degree in metallurgy, where new alloys can be created for virtually any application, but where the product engineer still prefers to stick to the old, tried-and-true materials.

The industrial designer is virtually forced to take a different approach. Inasmuch as new materials and new finishes are the principal part of the vocabulary with which he expresses his ideas, he must keep his information up to date by interviewing the representatives of materials-producing companies; by maintaining a current data file on all new materials and finishes, by seeing that his name is on the mailing lists of all major materials suppliers, and by studying the literature they send him. While time-consuming, none of this is actually difficult for the designer. The suppliers are aware that many of the more decorative applications of materials originate with the designer, and they are all eager to acquaint him with their wares.

The industrial designer also has the advantage of serving many different industries; and in so doing he becomes a sort of cross-fertilizing agent for ideas. A material application that he comes across in one industry may frequently be applied with advantage to another industry.

In this respect the independent industrial-design consultant has a distinct advantage over even the internal industrial designer—although the internal man, like the engineers with whom he works, may know much more about the technical problems of his product.

How can this breadth of experience help the product engineer? In a given situation some materials suggest quality, serviceability and other desirable properties; others do not. In the case of an exterior finish, the industrial designer's experience can help the engineer to choose from materials that have already proved their ability to help produce a more effective esthetic reaction on the part of the prospective purchaser.

Then, after a material is selected, the industrial designer often can suggest ways to enhance its appearance—darker trims to create the illusion of a lower silhouette, making certain sections of an extrusion convex, concave or textured to obscure draw marks, or specifying a satin finish for a polished surface when unpleasant halations would prove expensive to eliminate.

It is a fundamental principle of design that each material will look best when it is applied in such a way as to express its true nature. Conversely, it will look shoddy when it is used improperly.

Among the industrial designer's basic considerations in selecting a material are: 1) it should be one that will not deteriorate with age during the intended lifetime of the product; 2) it should perform satisfactorily throughout the entire range of temperatures and atmospheric conditions to which the product is likely to be subjected—not only in use, but while it is being transported; 3) it should possess sufficient impact and tensile strength; 4) it should have the desired thermal, dielectric and fire-resistant qualities; 5) its weight and price should be right for the intended application; 6) it should lend itself to automated or other economic types of production in the anticipated volume without excessive tool cost; 7) in the case of exterior surfaces, it should enhance the impression of desirability of the finished product.

ECONOMY, DURABILITY AND DEPENDABILITY are outstanding characteristics of these sintered metal gears. Parts like these are the result of close cooperation between Delco Moraine and its customers from idea through design and development to production.

DELCO MORAINE

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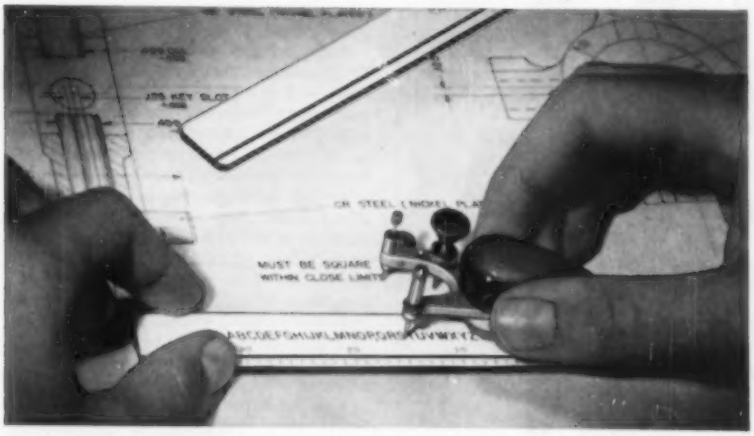
When it comes to lettering – plain or fancy – professionals the world over turn to LEROY® Equipment by K&E. In drafting rooms, art departments – not to mention schools, business offices, churches, clubs, hospitals – LEROY has become almost as necessary as pencil and paper.

Truly, there's no magic about LEROY – just a beautifully simple idea, translated into products which reflect the highest manufacturing skill and imagination. Not easy, we grant you . . . but not magic.



However, to keep the LEROY line constantly up to the changing requirements of the times – that *does* require a wizard. Fortunately, we have just such a gentleman firmly settled on the K&E payroll. And he begs that we report several of the more recent minor miracles of LEROY right here and now. So, in the famed standard, sans-serif lettering template, let's make with a little . . .

abracadabra

Templates

Every year sees new additions made to the already long list of LEROY templates. Case in point: the new electronic tube symbol templates for use in one of the most modern, fastest changing industries of them all. Also, there are foreign language templates (such as Russian and Greek), music templates, special designs, and a variety of handsome type faces (Caslon, Cartographic, Bernhardt Modern to name some newer additions).

The best advice we can give for keeping current on LEROY templates is to have the LEROY catalog on hand. (It just so happens that we recently put out a brand new edition of the catalog, and it's yours for the asking. See coupon at right.) Finally, of course, we should add that if you don't see what you need in our catalog, don't despair. We'll produce it, *custom-made*, to your design – as we have done for thousands of others.

A "Built-In" Pencil Point

The business of stopping work to put a sharp point on a lettering pencil is now largely over and done with, thanks to another new LEROY item. The point of the new LEROY "020" pencil never blunts or dulls – it's permanently sharp. And that, we submit, is a pretty sharp idea. The lead of this new pencil is an unvarying .020 inches in diameter, from one end to the other. All that's necessary to repoint is to advance the lead with a turn of the pencil shaft. No need to remove it from the scriber, by the way. This new pencil fits all LEROY scribers, and guarantees faster, smoother work. As to appearance – all lines drawn with the "020" are perfectly uniform, and of exactly the same density (a careful balance, chosen to give good wear without sacrificing print-making quality). You never saw pencil work look so good.

The Pen With A "Built-In" Inkwell

Here's your ticket to faster ink work with far fewer refills–K&E's new LEROY Reservoir Pen. You'll be amazed at the mileage you can get between refills with this newly perfected pen. Its refillable cartridge holds enough ink for many hours of smooth, uninterrupted lettering, thus eliminating the need for daily cleaning. The pen's cartridge is airtight – made of a non-porous, unbreakable, translucent material. The level of ink is always visible, and any non-solvent, waterproof India drawing ink can be used (for best results and quicker, easier filling we recommend the LEROY Lettering Ink-Cartridge #2950).

A tiny weighted needle inside the pen's feed tube assures a clear passage of ink from reservoir to point. Light vertical shaking of the pen activates this needle, removing any particles which may have settled in the tube when the pen was set aside. The needle also provides efficient cleansing action when you wash out the pen.

LEROY Reservoir Pens are furnished in seven sizes, from 00 to 5, for use with all LEROY scribers. Ideal for lettering work, the points glide easily over paper, cloth or film based surfaces, producing sharp, uniform lines that reproduce crisply.

Order Your LEROY Catalog Now

Other new additions and improvements – too numerous to go into here – are described in the new LEROY catalog. The coupon below brings your copy, free.

KEUFFEL & ESSER CO., Dept. PE-10 Hoboken, N. J.

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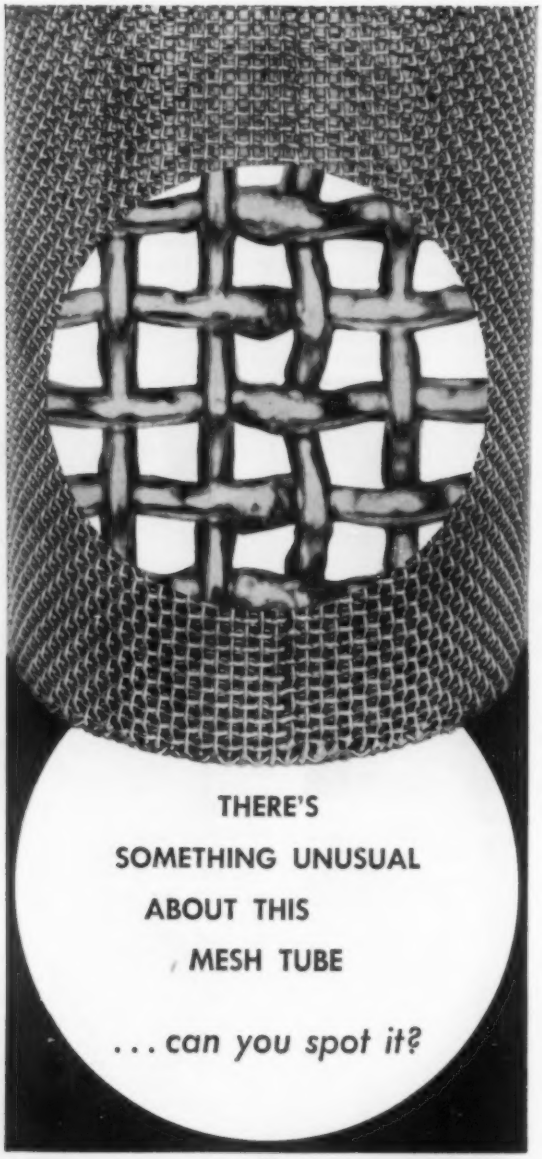

To the casual glance, this tube looks to be a routine job. But specifications called for an assembly that was, to put it mildly, unusual. Unheard of might be a better description.

Study the picture closely and you will note a rather dark streak down the center. This is where the two edges of the rolled cloth touch. The unusual feature is each wire is 'butt brazed' to its opposite wire. The assembled piece had to be completely devoid of a raised seam. Also you will note there is no excess spilling of brazing material.

Difficult? Yes, but we worked out an economical method.

We'll be glad to work on your mesh-assembled piece regardless of how difficult it may be to fabricate and assemble. And we have available thousands of variations of mesh, wire diameters and metal.

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READER TO EDITOR

US Invention Lag

To the Editor:

The lagging pace of US inventions (July 18, p 75) will continue and in fact deteriorate until the time when our country's laws and customs become flexible enough to establish real incentives for the inventor. As long as this man is required to assign his best thinking "without further compensation," we may hope for no improvement.

—JOHN R MCDOWELL
Knoxville, Tenn

To the Editor:

Your article on "The Lagging Pace of US Inventions" was a vehicle for much soul-searching. On page 15 of the same issue, an article states "The Lone Inventor Still Counts." Sixty percent of this nation's important inventions are coming from lone inventors or small organizations, why then are we lagging behind? Personally, I know of countless patentable ideas that are filed away because of the inventor's lack of faith in the system, his fear of theft (this is a "real" fear to many companies as well, who feel the best protection is to avoid a disclosure in the form of a patent) and the frustration of cost and the length of time necessary to obtain a patent.

The graph pertaining to the expanding R & D effort vs the number of patents issued cites a many-sided problem. One is the need of developing an application in the form of hardware to the theory that has existed up until today. Secondly, there is an internal fear in many of our largest R & D organizations that the engineer loses his value to the company once the program is complete. Some of the answers to be found amid the ramifications of our sad patent condition will involve the personal adventures in this field by our engineers and would-be inventors. We could learn why they have withdrawn from the race.

—E RUSSELL FAGERBERG
Central Engineering Laboratories
San Jose, Calif

Signing Patent Agreements

To the Editor:

Floyd H Crews ("That patent agreement—should you sign?" June 20, p 62) gives an able exposition of unenlightened corporate management's point of view which is like that of the sweatshop owner of old, namely: "I'll pay you as little as I want to." Mr Crews apparently believes that the arguments in favor of the company position are logical. Even if this were so, I question whether that is enough. I suggest that it is not moral for corporations to take advantage of their bargaining position so that an inventor employed by them for the purpose of invention loses all pecuniary rights to his inventions in return for only a steady salary.

I further suggest that instead of being logical in insisting on their one-sided terms, the corporations are being shortsighted because the kind of patent agree-

ment that makes a good inventor hesitate to sign is actually doing the company more harm than good. As Mr Crews points out, invention is a rare quality in most technical people. But present patent-agreement policies tend to guarantee that the companies will hire the less inventive rather than the more inventive engineers. Sharing rights to one really good invention may be worth a lot more financially than having exclusive rights to a multitude of lesser inventions. Therefore, instead of being so concerned about securing rights to employes' inventions only on their own terms the corporations might well be more concerned about the fact that they are not getting any rights to the good inventions of those who have been kept off their payroll because of their uncompromising policy.

Corporations and inventors have need of each other. The hostile attitude of the corporation that the inventor has only one choice—signing or not signing a one-sided agreement without modification—is not helping to get corporations and inventors together. I believe it would be of great mutual benefit to the corporation, the inventor and the public if the corporations would take a more conciliatory attitude in trying to secure the inventor's services by providing more liberal terms in their patent agreements. These could be provisions for royalty payments, profit-sharing or other incentives based on the success of the invention.

—CHRISTIAN D BERGER
North Canton, Ohio

COMING EVENTS

OCTOBER

5 . . . . Society of Plastics Engineers, Regional Technical Conf, Plastics vs Corrosion, Mark Hopkins Hotel, San Francisco

9-11 . . . . American Society of Mechanical Engineers, Rubber and Plastics Conf, Hotel Lawrence, Erie, Penna

10-14 . . . . Society of Automotive Engineers, National Aeronautic Meeting, Ambassador Hotel, Los Angeles

10-15 . . . . Institute of Radio Engineers jointly with ASQC, Reliability training Conf, Texoma Lodge, Kingston, Okla

13-14 . . . . Institute of Radio Engineers Symposium on Engineering Writing and Speech, Bismark Hotel, Chicago

16-21 . . . . Society of Motion Picture and Television Engineers, International Congress on High-speed Photography, Sheraton-Park Hotel, Washington

17-19 . . . . American Society of Lubrication Engineers jointly with ASME, 7th Annual Lubrication Conf, Statler-Hilton Hotel, Boston

17-21 . . . . American Society for Metals, National Metal Exposition & Congress, Trade & Convention Center, Philadelphia

N-83 ACTUAL SIZE

NEW G-E GLOW LAMP (NE-83) EFFECTIVELY HANDLES CURRENTS UP TO 10 m.a.

Here's a General Electric Glow Lamp that operates at currents many times higher than most glow lamps. At 10 milliamps, the NE-83 will hold its breakdown and maintaining voltage within five volts of initial for an average life of 500 hours. Life will be correspondingly higher at lower currents.

Although this product is too new for us to establish voltage regulation specifications, it shows considerable promise for this application in the 1 to 10 milliampere range.

Leads of the NE-83 are plated for easier soldering. It contains a mild radioactive additive to reduce breakdown voltage in darkness.

DIRECT CURRENT SPECIFICATIONS

Breakdown Voltage	60-100 volts d-c
Maintaining Voltage at 10.0 m.a.	avg. 65 volts d-c*
Design Current	10.0 m.a. d-c
Life (at 10 m.a. d-c for an average change of 5 volts in breakdown and maintaining voltage)	500 hours

*Average after 100 hours burning at rated current. Individual lots may vary from average.

There's a General Electric Glow Lamp to suit every circuitry need. For the latest information on Glow Lamps as Circuit Components and Indicators, write for 4-page Bulletin #3-0193. General Electric Co., Miniature Lamp Dept. M-038 Nela Park, Cleveland 12, Ohio.

Progress Is Our Most Important Product

GENERAL ELECTRIC

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HANDY & HARMAN SILVER BRAZING
Permits Manufacturer to Guarantee Underwater Air Regulator For Life

Perhaps the most vital component of a skin diver's equipment, this Viking Air Regulator, manufactured by Christensen Tool & Engineering Company, Norwalk, Connecticut, is structurally guaranteed for life. It must, under all conditions, be absolutely leaktight. The manufacturer's guarantee is a relatively recent achievement—through the high-strength help of silver alloy brazing with Handy & Harman EASY-FLO 45 and HANDY FLUX.

Over and above the unreserved dependability of brazed joints, the brazing method itself has saved the company considerable time, money and material in the production of the Viking Air Regulator. Brazing's simplicity is interestingly illustrated in this case by this company's requirement that assemblers and testers of the Viking must be skin divers themselves.

Almost invariably, silver brazing effects economies and brings advantages to whatever part, product or assembly it is applied. True, air regulators are few and far between, but the point is that they are *metal products, made of a number of different metal components.*

And that's the phrase that covers brazing's great adaptability. To give you a good idea of how you can put brazing to work, we'd like to send you Bulletin 20—it covers the basics of brazing and it may very easily solve your metal-joining problems. Handy & Harman, 82 Fulton Street, New York 38, N. Y.

Here, in "serial" form is how the guarantee is "brazed" into the Viking:

1. TANK HOUSING—Initially, this component was mechanically joined and made "airtight" by means of sealants. Now, brazing eliminates 8 holes, 4 tapping operations, 4 screws and 3 assembly operations.

5. Shown here are the finished Viking components before and after assembling. —Brazing by Specialty Brazing Laboratories, Riverside, Connecticut.

3. YOKE—This is assembled from stampings instead of castings, which were previously used. With brazing, no secondary finishing operations are required. Further, the part is stronger and lighter, and savings on material and labor on this component alone add up to 28%.

2. FORK ASSEMBLY—There are five separate brazed joints, done with hand torch and hand-fed wire. Brazing eliminates one tapped hole, a lock washer and a spacer, plus the fact that positive alignment is now guaranteed.

4. PISTON—This is the most important single element of the Viking. It regulates flow of oxygen from cylinder to mouthpiece; from 300 lbs. pressure to normal breathing. Without brazing, this part could not be made.

Your No. 1 Source of Supply and Authority on Brazing Alloys

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General Offices: 82 Fulton St., New York 38, N. Y.

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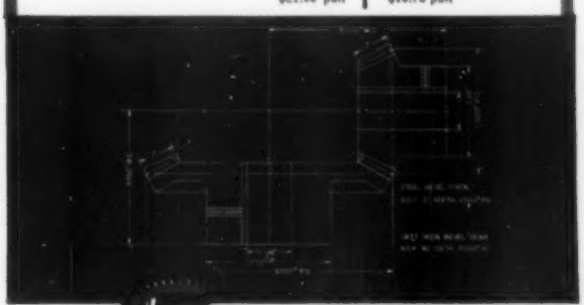
Gregory Grant says —

COMPARE THE COSTS!

MAKE YOUR OWN COMPARISON . . .
CALL ANDREW 8-4409 COLLECT

Here is a typical comparison — 50 sets of gears and pinions to meet assembly specifications:

Set of stock gears unaltered	$20.20	Set of Grant customized gears to your specifications, ready for installation
Rebore shaft hole/per pr.	.80	
Cut keyway/per pr.	.50	
Drill and tap for set screw/per pr.	.40	
	$21.90 pair	$15.75 pair



We believe we can prove on your next O.E.M. application that you can save 25% in actual costs when you specify Grant *customized* gears, instead of making time-consuming alterations to stock gears to fit your needs.

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WHY DON'T THEY R&D..?

. . . a sweetness-measuring instrument for the food-processing industry. Sweetness, like odor, is a physiological sensation and therefore difficult to classify with any kind of nonhuman measuring instrument. The chemical compounds that are sweet to the taste are well known (besides sugar, there are saccharin, sulfamate, stevioside, perillartine). But we have no instrument that will identify each of these agents and register sweetness in proportion to the difference in their sweetening powers. —B ARNOLD

. . . a wristwatch-size altimeter for hunters, fishermen, mountain climbers and cave explorers. For continental United States, it should cover the range between 300 ft below sea level to 15,000 ft above sea level and be readable to the nearest 100 ft. To correct for changes in barometric pressure, the instrument should have an adjustment so that it can be set when either altitude or barometric pressure is known. Perhaps a novel design is needed; necessary price and size would seem to preclude the conventional aneroid or Bourdon-tube movement. For convenience, a small magnetic compass could be built into the same instrument as shown in the sketch. —J J O'CONNER

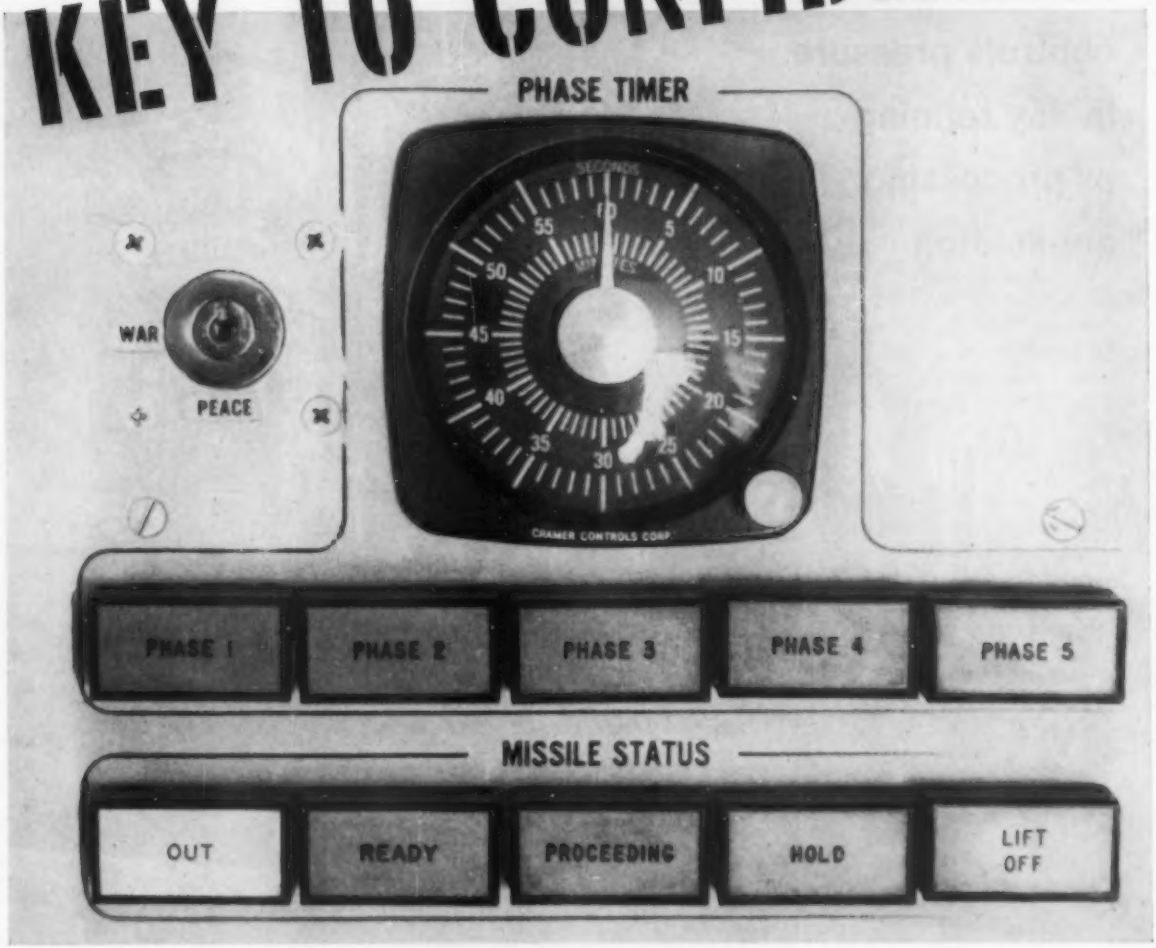
. . . bolts that give a continuous indication of tensile stress. Stress-indicating bolts could be used where a fastener must be tightened to a critical torque value but, because of obstructions, cannot be grasped with the ordinary torque wrench. Also, they would show changes in stress that occur after the bolt is in place. Perhaps a large bowed disk or a spacer similar to a Belleville washer could be coated with a photoelastic material and calibrated to give a stress reading. Or stress might be determined by applying a high-frequency vibration to the end of the bolt and measuring resonant frequency. Resonance could be correlated with bolt size and material to give stress. —F P RANSOM

. . . neon indicator lamps in colors other than red or amber. The new high-output neons have pretty well solved the problem of low illumination. And the other inherent advantages of neon lamps—long life, good vibration resistance, low heat output, power directly from 110-v lines—make this type of lamp a preferred choice for instrument and control panels. But applications are limited because only a narrow range of colors is available. —T N TYLER

. . . a chemically activated self-cooling beverage bottle or can. Some time ago, self-heating tins of coffee were supplied to members of the armed forces as a part of their kit of field rations. They were simply double-wall cans with a chemical in the annular space; when activated, the chemical heated the contents. A self-cooling can might be made along similar lines. A fluid that evaporates quickly (ether or alcohol, for example) could be used in the annular space to cool in a manner similar to the quick-freeze instruments used by doctors to deaden small areas of the skin prior to minor operations. —R MARIE

Have you a problem, based on known scientific principles, which seems to have an answer somewhere within the limits of present technology? To inspire inventors along worthwhile paths, PRODUCT ENGINEERING invites you to trade such problems with fellow readers who have a fresh viewpoint or more time to experiment. We pay $10 for each one accepted.

KEY TO CONFIDENCE



CRAMER TYPE 691 PRECISION TIME TOTALIZER

This is a ballistic missile control panel, somewhere in England. You may have seen it in a recent issue of either of two leading weekly news magazines . . . and read about two keyslots: "War-Peace", to permit activation of the atomic warhead, and "Launch Sequence", to initiate the intricately synchronized steps that lead to lift-off.

Once that sequence is started, each of the five phases of the 15-minute countdown is completely automatic, precisely indicated by a Cramer Type 691 Time Totalizer. Human hands begin the cycle, and may stop it before the fateful last minute. But no hands are deft enough to guide it through its complex dance.

Here, as in many less dramatic instances, the key to confidence is a Cramer timing device.

Time Ranges: 60 seconds or 60 minutes. Outer scale reads either seconds, .01 second, or .01 minute intervals.

Motor Ratings: all standard voltages at 50, 60 or 400 cps, and 28v DC chronometrically governed.

Accuracy: within .01 second or .005 minute.

Reset: in 1/10 second, by dial pushbutton or remote control.

Load Switches: Optional. SPDT, rated 5 amps at 115 and 230 volts, AC or 2 amps at 28 volts DC.

Cams: Optional, to operate load switches. Cut to user requirements.

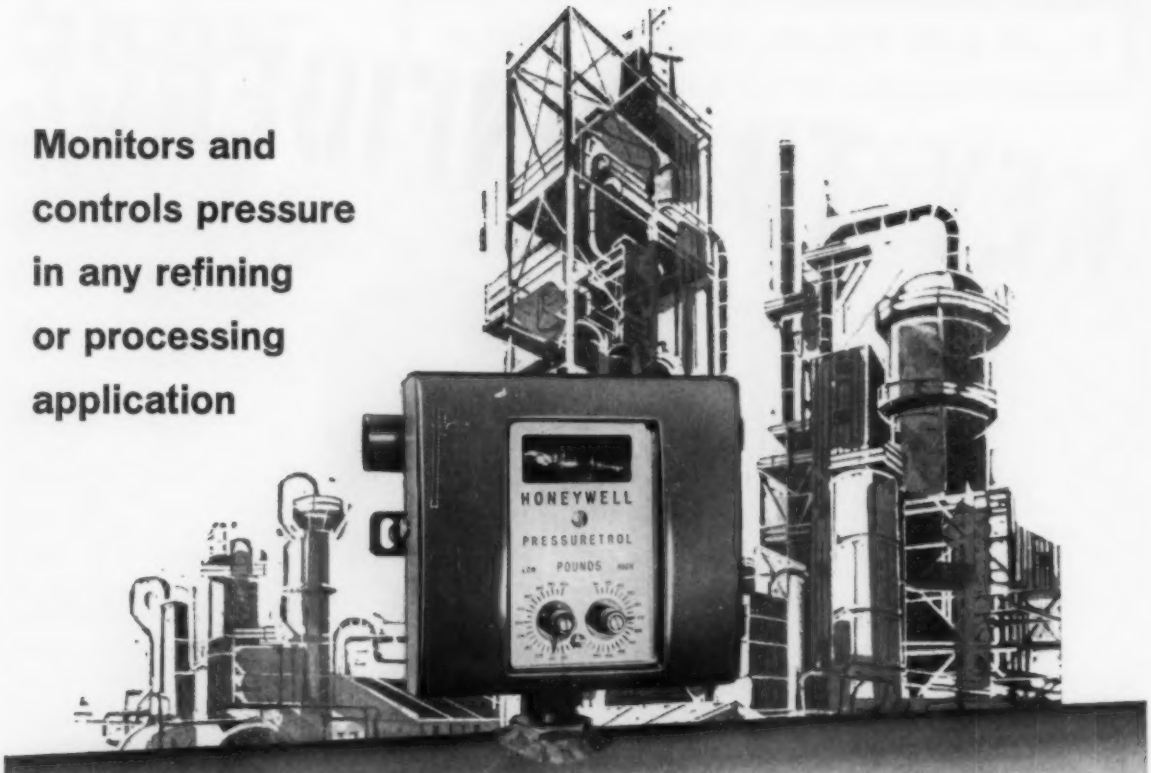
MIL-Specs: Hermetically sealed military units meet vibration, shock and environmental tests of MIL-E-5272B.

ELECTROMECHANICAL DIVISION

CRAMER CONTROLS CORPORATION

CENTERBROOK, CONNECTICUT

Monitors and controls pressure in any refining or processing application



Honeywell's versatile Bourdon-tube PRESSURETROL*

- **Suitable for all gasses, fluids and steam**
- **Ranges from 30 to 3000 psi**
- **Standard and explosion-proof models available**
- **FM, UL, FIA approved**

Honeywell Pressuretrols precisely measure and control pressures of any fluid, gas or steam. They can be used to sound an alarm or control a valve, pump or compressor. These are heavy duty devices designed specifically for industrial use.

The Pressuretrol can be flush or surface-mounted on a panel, or installed directly on a pipe. Settings are made with one high and one low pressure knob conveniently located on face of the unit. The mercury switch can be easily seen through a protective glass window. Depending upon pressure range, bronze, stainless steel and beryllium copper Bourdon tubes are available. Choice of control to make on pressure rise or fall.

Model P428		Model P444	
Range (psi)	Maximum (psi)	Range (psi)	Maximum (psi)
30—300	375	20" vac—40	75
50—600	750	1—20	50
100—1000	1200	5—50	80
200—2000	2400	5—150	200
300—3000	2500		

No matter what your pressure-control need, Honeywell can supply it for you. Call your local Honeywell office or write Honeywell, Dept. PE.10-41, Minneapolis 8, Minnesota. In Canada, write Honeywell Ltd., Seaside, Toronto 17.

See us in Sweet's 1960 Product Design File, Section 5b-Min.

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First in Control

SINCE 1885

75th YEAR — MEASURING THE FUTURE

PRODUCT ENGINEERING **HORIZONS**

October 3, 1960

A 3-g WORLD?

Current efforts to develop antigravity point up a theory recently advanced by Dr Reginald O. Kapp ("Towards a Unified Cosmology"– Basic Books, $6.50). He calculates that the value of gravity 2000-million years ago may have been more than three times that at present, and that it has been steadily reduced as the earth shrank. Thus our little g must once have been a big G indeed.

If so, the atmosphere was denser and shallower, so there was little evaporation, hence no clouds and no steamy humidity. Usual weather was a fierce glare; the occasional raindrops hit like bullets. Average wind velocities were high, even under small local temperature changes, and the dense wind had hurricane force, making plant life as we know it impossible. A tree could not support its heavy leaves, let alone its cantilevered branches; a stalk couldn't support even a flower; an animal couldn't support its head nor could its bones support its tissues. The only safe place was the sea.

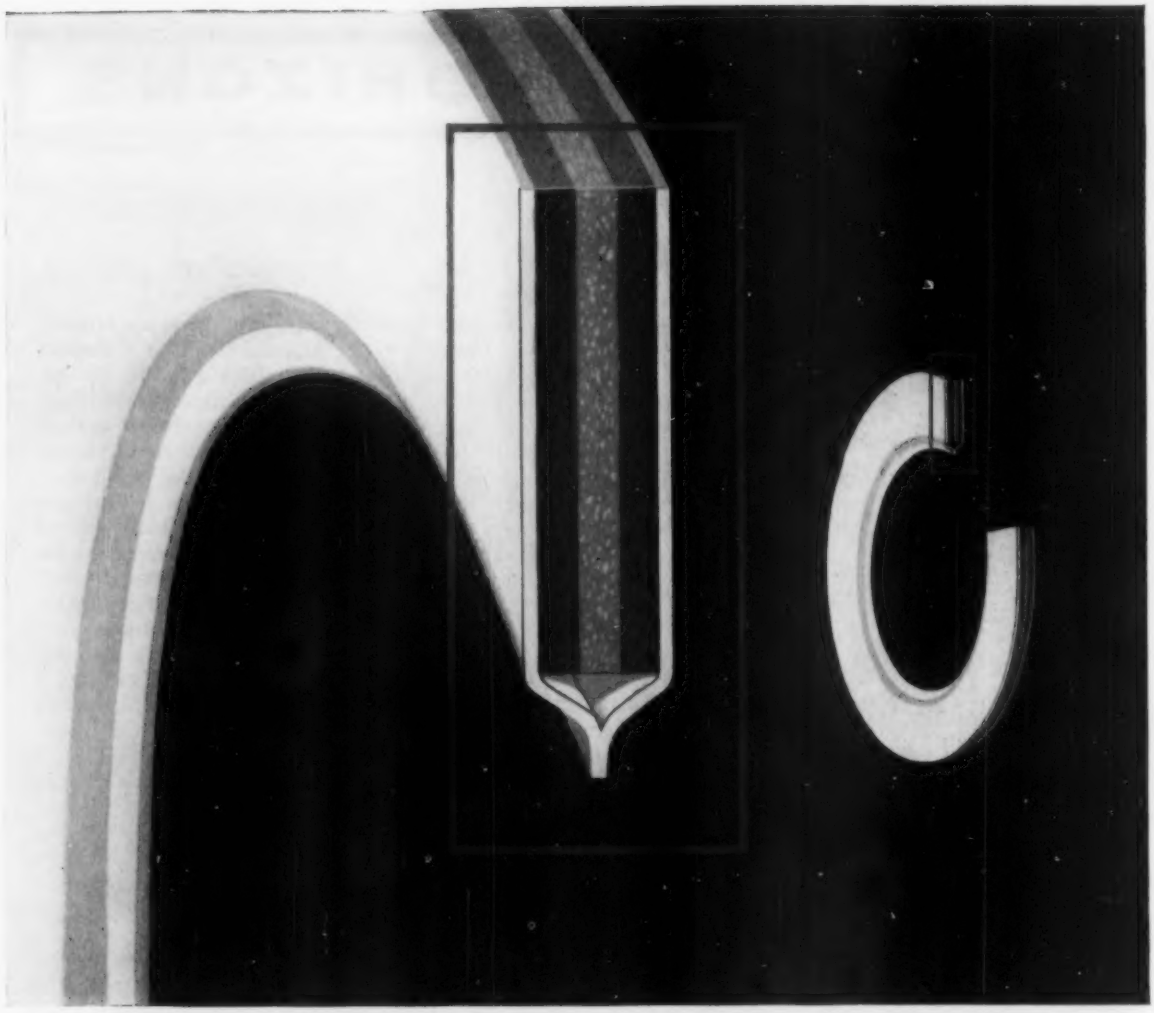
Cut g to twice its present value, and saurians are possible, crawling because walking is too difficult. Swamps provide water for assistance in supporting the body, but the pressures are still too great for easy blood flow, so brain development is hampered. But continue to reduce g, and stilt-like legs, giraffes, and man's huge blood-fed brain become possible.

An interesting theory this—and one just as tenable as that of gradual evolution. It has the virtue of providing an explanation of the delay between apparent readiness of our earth to receive living things and their actual development—a delay of some hundreds of millions of years. There couldn't have been plant life generating oxygen in a 3-g world, hence no animals to breathe it.

In our thinking and planning for the future, we forget how puny man himself is—that, although we have adapted ourselves to a wide range of temperatures and environments, there are still larger ranges in which man himself cannot exist. The dinosaur went because he couldn't adapt himself fast enough to a changing environment; the same thing could happen to us—a cosmic change too rapid for adaptation, for example.

Is there, out in space, another world with beings roughly like us, where gravity is so low that their superbrains have thought their way around our troubles? Or are their troubles just that much bigger—as ours seem to have grown with our brains? And when we put men in space, where there is no g at all, will their children grow the superbrains we seem to need?

F. Stangerman



Rely on the gaskets especially designed to handle corrosives, even in glass-lined equipment!

J-M CHEMPAC® GASKETS COMBINE ASBESTOS AND TEFLON FOR LONGER SERVICE PER DOLLAR INVESTED

Here's the gasket that can scoff at active chemicals and solvents. That's because the envelope-type design combines the protection of both compressed asbestos filler and Du Pont Teflon.

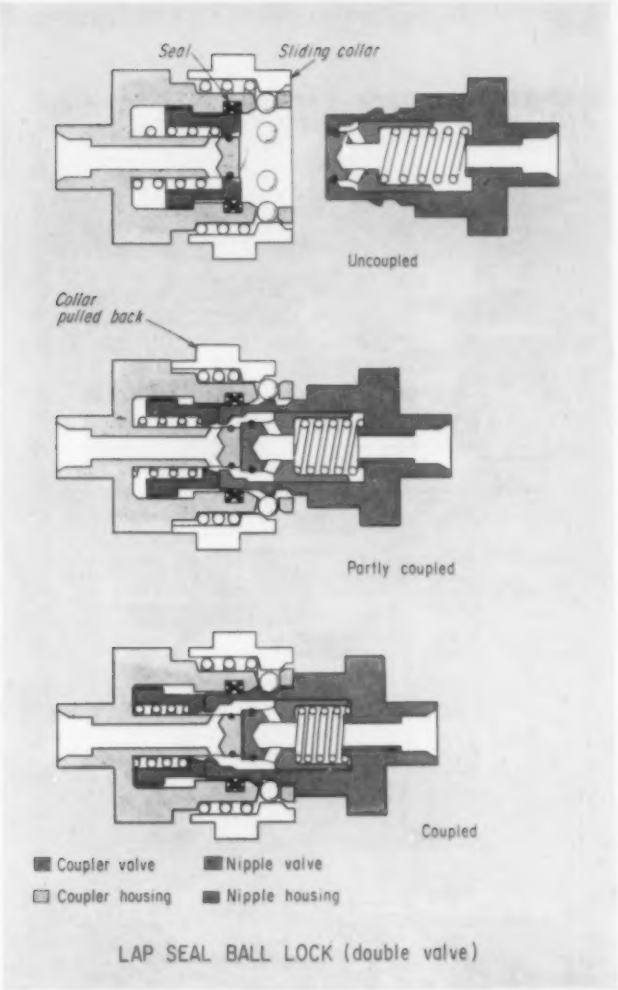
A center core of compressed Chrysotile Asbestos is sandwiched between two layers of felted Blue Asbestos. These three asbestos layers provide longer life . . . outstanding corrosion and heat resistance . . . and the "cushion" effect so desirable in glass-lined equipment. A split or welded envelope of electrical-grade Teflon is then added for even greater corrosion resistance.

Chempac Gaskets are soft, conformable and effect a seal at low bolting. Available in pipe sizes from ½" to 12" as standard. Other J-M envelope-type gaskets are also available in various sizes and with special fillers for specific requirements.

It will pay you to solve your corrosive sealing problems with Chempac Gaskets—*especially designed* for that purpose. You can rely on them to give you the most effective sealing . . . and longest, most economical service per dollar invested. See your J-M Distributor. Or write to Johns-Manville, Box 14, New York 16, N. Y. In Canada: Port Credit, Ont. Ask for Chempac Book, PK-124 A.

JOHNS-MANVILLE

PRODUCT ENGINEERING



LAP SEAL BALL LOCK (double valve)

FOR HYDRAULIC AND PNEUMATIC SYSTEMS

QUICK-CONNECT COUPLINGS CUT COSTS

And these plug-ins have a tight joint you can make or break in a hurry. Some are valved types that act fast when the coupling is parted, holding spillage to a minimum.

GEORGE HAGGER
Vice-president and chief engineer
Snap-Tite Inc, Union City, Penna

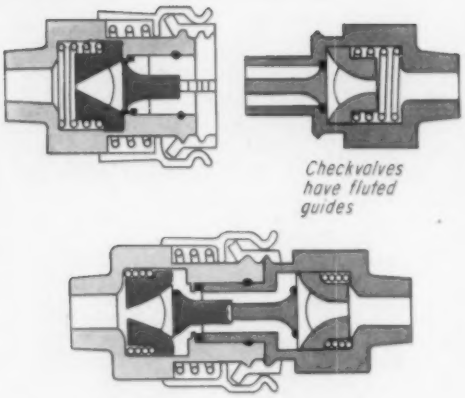
The double-valve arrangement in quick-connect couplings lets you join together two parts of a hydraulic or pneumatic system about as easily as plugging an appliance into an electric outlet. When the two parts mate, a valve in each automatically opens and the liquid or gas flows through the union immediately. Disconnecting is just as simple—when the halves of the couplings are disengaged the two valves close, stopping the flow.

Two other kinds of quick-connect couplings are available. One is plain (straight-through); it has no valves. This type has been used for years at your local gas station to join the rubber air hose to the pipe from the compressor. The other has a valve in its coupler; its simpler half, the nipple, is plain. This combination can be economical where many units containing nipples, such as a

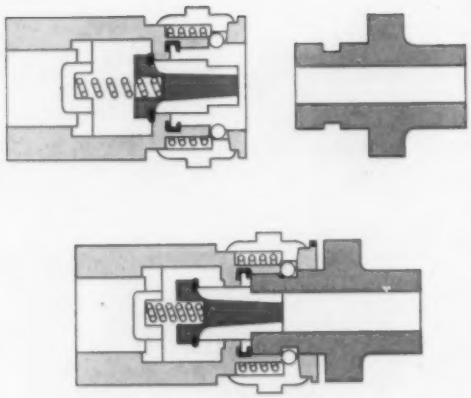
text continued on page 39

REPRINTED—Circle P63, inside back cover

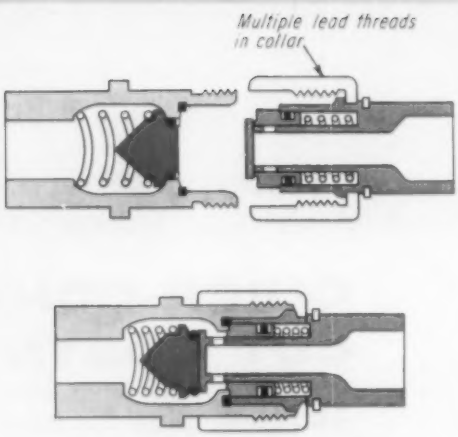
REPRESENTATIVE TYPES AND HOW THEY WORK



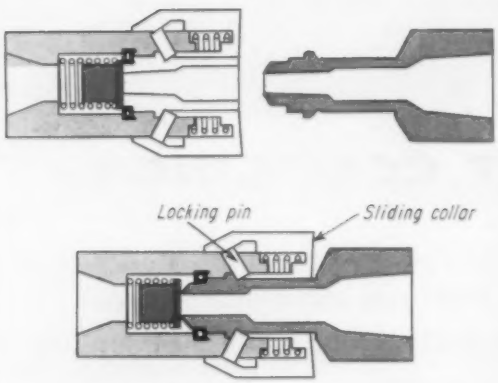
Lap-Butt Seal, Dog Lock (double valve)



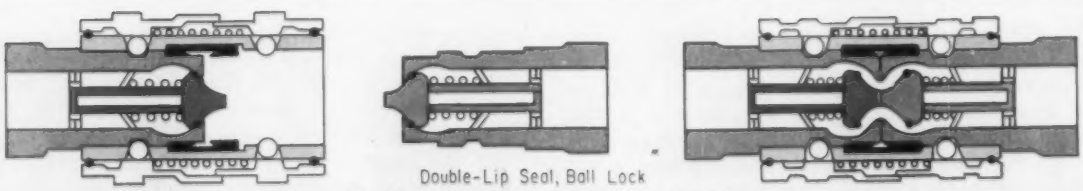
Butt Seal, Ball Lock (single valve)



Butt Seal, Twist Lock (double valve)



Lap Seal, Pin Lock (single valve)



Double-Lip Seal, Ball Lock
(Double valve; either nipple can be uncoupled)

Seals for Quick-connects

Buna N	Excellent for petroleum oils, gasolines. Good for aromatic hydrocarbons, acids, bases.
Butyl	Excellent for vegetable oils, dilute acids or alkalis. Good for nonflammable hydraulic fluids. Resists gas permeation.
Polymerized chloroprene (Neoprene)	Excellent as tasteless, odorless seal for food industry. Excellent for Freon.
Silicones	Excellent for temp. extremes (—100 F, or lower, to 500 F). Excellent resistance to weathering, aging. Good for oils, many chemicals. Poor physical properties (compared to Buna N) such as tensile strength and tear and abrasion-resistance.
Polysulfide (Thiokol)	Excellent for solvents, ozone, low-temperature flexibility. Poor physical properties, heat resistance.
Fluorocarbon rubber (Teflon, Kel-F, Viton A)	Excellent for fuming acids, strong bases, petroleum oils, synthetic lubricants, fuels, silicate esters, some solvents, especially up to 500 F.

set of pneumatic power tools, connect to a single coupler. Several types are shown on these pages. See p 37 for color code used to label parts.

When to Use Them

Where downtime is critical in a hydraulic or pneumatic system, quick-connect couplings can simplify removal of the major components for repair and replacement.

And these couplings will more than pay for themselves in such applications as window air conditioners, portable dishwashers, car-wash equipment, fuel-oil carriers, brake systems, and some production operations where sealed assemblies must be initially charged (such as refrigerant systems).

What's Available

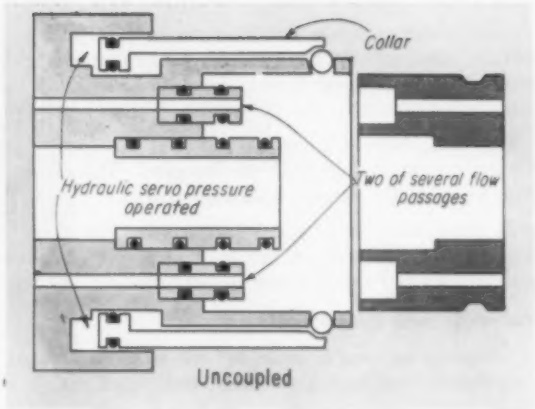
You can get quick-connect couplings for various temperatures from —300 to 500 F. Some are designed to withstand vibration from 100 to 2400 cps over extended periods of time, pressures to 3000 to 4000 psi, and as many as 1000 connects and disconnects. Most commercial applications have far less stringent requirements.

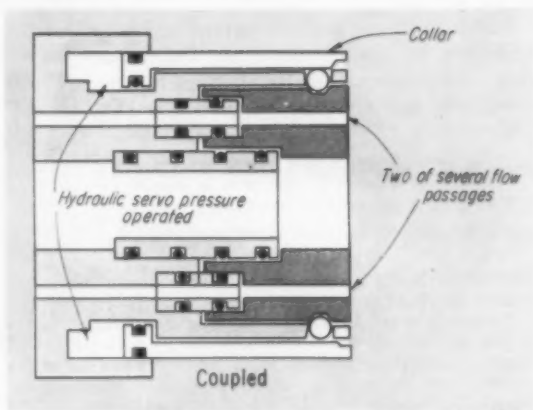
Sizes generally range from ¼ to 1¼ in. (pipe-thread size of the fittings); for special applications they go up to 3 or even 4 in.

There are couplings for practically every gas or liquid—corrosive and noncorrosive; organic (fuels) and nonorganic (acids, alkalis).

How They Lock

Different manufacturers use different methods to lock the coupling halves. These four types (illustrated on p 37) are the most popular:





SPECIAL CONNECTOR has multiple passages for handling several fluids. This is an unvalved, straight-through type, which means internal pressure must be removed when coupling or uncoupling. Hydraulic pressure keeps collar in locked position.

Balls in races. The coupler is designed to hold a number of circumferentially spaced balls. The nipple is machined and heat-treated to provide an inner race that retains the balls when the assembly is coupled.

Pins and grooves. A radial cam drives locking pins into a retaining groove in the nipple; spring-loaded detent secures the assembly. Sometimes cams are mounted around the internal circumference of the nipple. A rotation of about 90° draws the two parts together; they are then locked by a spring detent.

Dogs in the coupler body. The dogs pivot into a locking groove in the nipple as the locking sleeve is moved into position.

Simple threads. The nipple contains the male and the coupler has the female threads (usually they are multiple-lead to reduce the number of turns required). The coupler sleeve is screwed onto the nipple, then locked by a spring-loaded detent or ratchet.

How They Are Sealed

Lap seal uses a flat, U-shape packing seal. The coupler and the nipple overlap to form the seal. This design pro-

vides tighter sealing as pressure increases. However, it is subject to seal extrusion at higher pressures. The manufacturer can minimize this tendency by holding close tolerances. The lap seal is not suited to low-pressure or vacuum applications.

Butt seal. Here the packing seal is at the end of the nipple, forming a butt with the coupler. This method is suitable for all pressures, including vacuum.

In some seals, an O-ring substitutes for the U-shape packer. One variation of the lap seal is the double-lip seal; another is a combination lap-butt seal.

Materials and Finishes

Couplings are usually made of brass plated with nickel and chrome; anodized aluminum; steel plated with cadmium, cadmium chromate, or nickel; or stainless steel, Types 303 and 316.

Seal materials are generally natural or synthetic rubber, depending on type, temperature, and pressure of the fluid. The table on preceding page lists some typical compounds and appropriate conditions. High pressures add problems of permanent set and cold-flow extrusion.

How They Perform

Speed of disconnect is generally a fraction of a second, and is accelerated by the internal line pressure. The check-valves are usually spring-loaded to ensure rapid action. One special application specifies a time of 2/5 sec at 3000-psi internal pressure.

Couplings can be joined or separated by hand; but for safety, larger sizes are limited to lower internal pressures. For instance, a man can safely connect a ¼-in. coupling at 200-psi internal pressure, or a 1-in. unit at about 65 psi. Systems handling higher pressures are usually manually connected and disconnected while internal pressure is reduced. They can be remotely disconnected under high pressure by using solenoid valves, lanyards, or other means. One special high-pressure connector (*PE*—Sep 14 '59, p 97) can be disconnected with one hand while internal pressure is 4000 psi. It is used with compressed air to start jet engines.

How Much Liquid Spills?

When a coupling is disconnected under pressure, it is only natural that some of the liquid will spill. But not much. For instance, ¼-in. couplings, depending on design, will spill anywhere from 6 drops to about 1.5 cc during the disconnect cycle, with an internal pressure of 60 psi. Stepping up to 1½ in., with an internal pressure of about 10 psi, spillage will be about ten times as great.

For REPRINT of above article, just check P63 on one of the Reader Service cards found in this issue.

EDITOR'S NOTE: For more information on couplings for fluids, see:

Designing with Swivel Joints, Aug 4, Dec 8, Dec 22 '58—Three articles compare swivel joints with metal and rubber hose, give three methods to plan swivel joints and give torque and pressure loss charts.

Updating the K-factor, Apr 14 '58, p 74—Simplifies pressure-drop calculations in valves and fittings.

Maintenance Advice for Fluid Circuits, Mar 17 '58, p 71—A checklist covering the principles give preventive and trouble-shooting—that will keep hydraulic equipment working properly.

How Much Hp to Pipe Liquids?—an 6 '58, p 89—Estimates power loss.

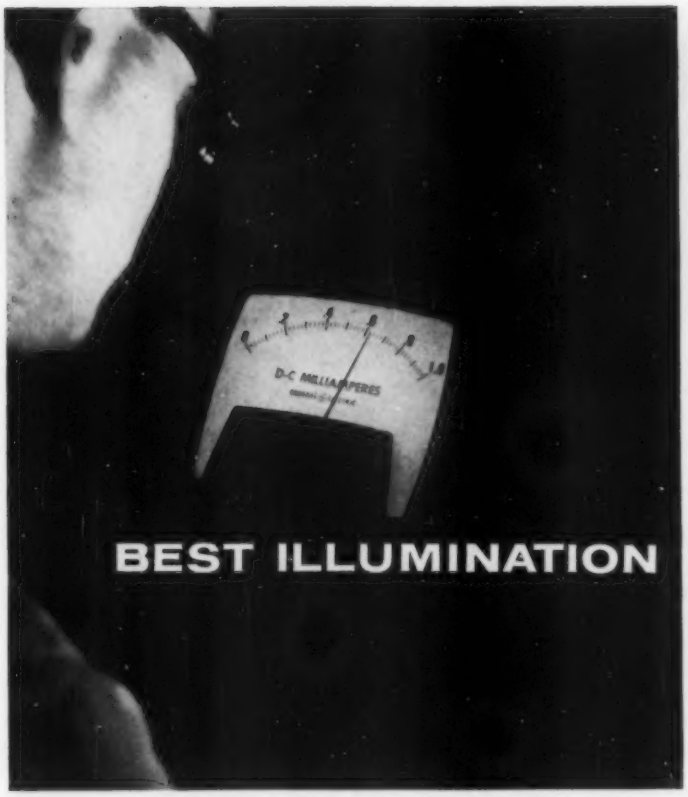
TO FORGE TUNGSTEN— do it fast

With usual forging methods tungsten is brittle and difficult to work. But on the Dynapak high-velocity press, billets are readily forged into cup-shaped pacts with sharp inside corners, as shown here, or even extruded with a finished section reduced by 16:1 from the blank. The cup illustrated is 2½ in. dia.

Ram of this forming machine delivers a blow of 160,000 ft-lb in 0.001 sec, striking the forging or extruding die at 400 fps. Ram is powered by 2000-psi gas, triggered by a part systems that delivers the pressure in an exceedingly short time. (For a diagram of the system see PE—May 23 '60, page 41).

Under this high impact energy, many difficult-to-form materials become ductile and tough during forming, exhibiting flow properties normally obtained only at elevated temperatures. In forming tungsten parts the impact refines grain structure to produce a more ductile finished part than obtained from low-velocity forming. Also, die wear is reduced and finished surfaces of the part are smoother.

The Dynapak machine is based on a device developed by Convair for shock-testing missile components, and was first shown in 1958 (*PE*—Nov 10 '58, p 38). Appearance design accomplishments in the machine and control console won a PRODUCT ENGINEERING Design Award in 1960.



BEST ILLUMINATION FOR INSTRUMENT DIALS

Light needed for fast and accurate interpretation of pointer-and-scale indications can be supplied by floodlighting or by translucence—each with its own problems. Now comes a new method—electroluminescence.

PETER B TROUP
Instrument Dept
General Electric Co, West Lynn, Mass

Electrical indicating instruments pose a special problem in adequate illumination for accurate reading. If they depend upon external lighting, reflections from the glass cover over the scale may make reading difficult, and a high intensity is needed with no shadows. The varying intensity of daylight is an added problem.

When good lighting of an instrument dial is needed under conditions of a varying ambient illumination, internal lighting may be the best answer. Several methods of such built-in illumination are available: floodlighting from front of dial; trans-illumination with light behind the dial; and now, electroluminescent dial surfaces.

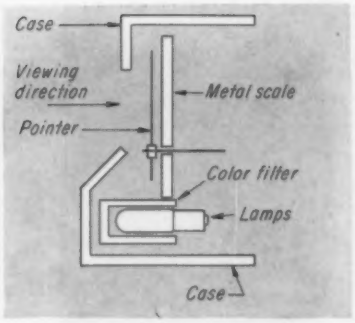
WHAT THE EYE NEEDS

Just how much light is needed to read the position of a pointer over a graduated scale? This is mainly a problem in human response. Under conditions of low ambient light an intensity of 1.5 foot-lamberts on a white scale plate is adequate. But in a darkened room or an airplane cockpit at night, a dial internally lighted to this intensity is far too bright—the dial lighting should be dimmed to 0.5 to 0.1 foot-lamberts.

Should the numbers and scale divisions be white on black background, or vice versa? Most of us are conditioned to black on a white background; with indicating instruments this has the important advantage of making it unnecessary to illuminate the pointer. However, military specifications invariably call for black background with white scales and pointers. This requires illumination for the pointer—which must be lighted somewhat brighter than the scale so the pointer will be seen last when lighting is dimmed. Also, the background must not be dead-black or the instrument will appear to float in air when viewed in darkness. The background color should give an intensity of about 10% of the spot intensity of the graduations.

Another psychological problem arises from the eye's tendency to integrate total light instead of responding to

Mr Troup is now staff engineer, Aero Space Div, Boeing Airplane Co, Seattle.



INTERNAL FLOODLIGHTING distributes light from built-in lamps over the front of the dial. Color filters can be added when needed for special viewing problems such as low illumination for night vision in aircraft.

spot intensity alone. An illuminated black dial with many white graduations will appear brighter than one with few graduations even though the spot intensity is exactly the same. Or a white dial of the same intensity but with many scales and graduations will appear less bright than one with fewer markings.

The subjective nature of these responses points to why it is difficult to measure and specify how much light is needed for an illuminated dial—measurement brings difficulties in calibrating or standardizing the measuring instrument and selecting the size of the measured area. One of the best instruments is the Spectra-Brightness meter made by Photo Research; it measures the light intensity of a spot 0.015 in. dia through a microscope. This area is small enough to give brightness readings on a portion of a numeral or graduation.

Because of standardizing difficulties when close tolerance is needed, the specification of intensity is best made by transfer standard. A sample instrument is carefully measured by the instrument manufacturer and shipped to the customer with precise data on test conditions and measured values. By this means, vendor and user specifications can be brought together.

THE 3 METHODS

Floodlighting

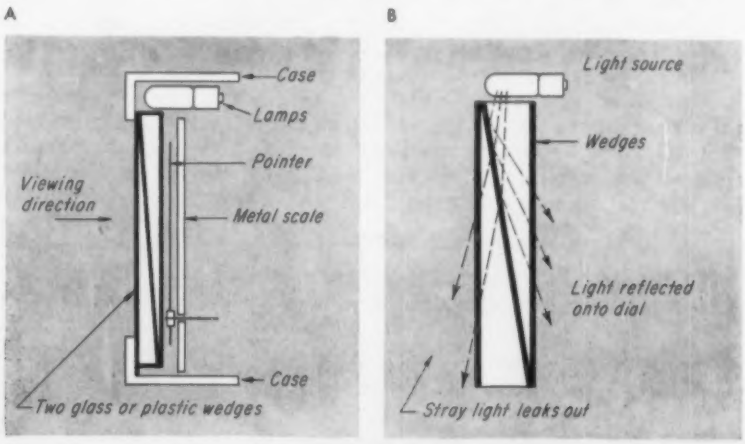
Built-in lamps are easy to apply, providing that requirements for uniformity in intensity are not too critical. The construction is inexpensive, and lamps can be replaced from the front. But with the light source at one side, the intensity will vary across the dial. Also, there is usually at least one position where the light shines directly on the operator, and glare will affect vision.

In wedgelighting, a version of floodlighting, the front window is replaced by a mating pair of glass or plastic wedges, edge-lighted by built-in lamps. Once the wedges are designed, this method of lighting is easy to apply and distribution is fairly uniform. But some stray light will come out of the bottom of the instrument, and the wedges are heavy and costly. Also, the added thickness pushes the dial back in the case, leading to decreased visibility from the side.

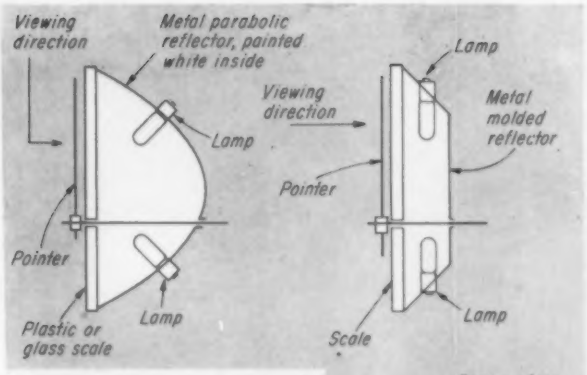
Trans-illumination

A translucent dial is lighted from behind by lamps mounted in a metal reflector. This method, limited to white dials with black pointers, provides uniform illumination at low cost, and filament position in the bulb is not critical. Major problem is increased length of the pointer shaft, which brings vibration problems, particularly on low-torque instruments. Reflector depth takes up much space, but this may be reduced by using a shallower reflector that has been carefully shaped to maintain uniform illumination.

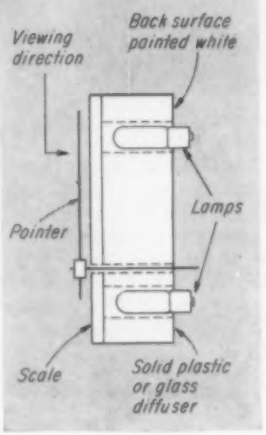
A substitute method places a plastic or glass diffuser behind the dial. This provides fairly uniform lighting by multiple reflection within the diffuser. Space required is less than for a reflector and the method can be applied to large panel areas. But filaments must be inside the diffuser and variations in filament position within the bulb may



WEDGELIGHTING depends on internal reflection from edge-lighted plastic wedges (A). This gives good distribution of light but some light leaks out (B), and increased thickness of front cover reduces dial visibility from the side.



TRANSLUCENT DIALS LIGHTED FROM BEHIND with a white-surface reflector give good light distribution at low cost, but require long pointer shafts. Lamp position is not critical. Metal reflector (A) or (B) may be replaced with a plastic diffuser (C) but filament position becomes more critical and temperature of the plastic must be kept under 200 F.



affect uniformity of lighting. For plastic diffusers, the temperature must be kept below 200 F.

With black-background dials, this method offers difficulty in getting illumination to the pointer. A pyramid molded in the center of the diffuser can direct a beam of light forward to a translucent pointer. Back face of the pointer is painted white, and is lit by diffused light in the body of the plastic pointer. A painted front surface of the pointer gives a pleasing appearance but requires a brighter light source. A glass pointer is sometimes used instead of plastic, but the increased weight presents a problem for low-torque instruments.

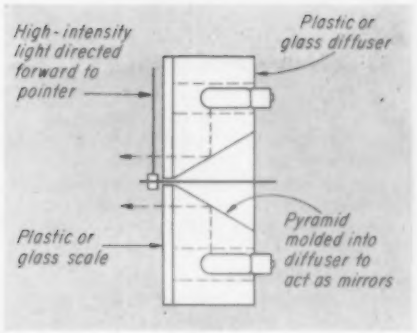
Electroluminescence

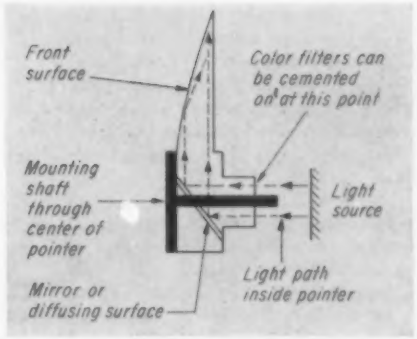
Plastic or ceramic electroluminescent materials can provide an illuminated surface on a dial plate. Scales and graduations may be painted on, or left lighted by masking the background with paint. Plastic materials are inexpensive, and can be formed into special shapes. Lighting of pointers can present a difficult problem since slip rings are needed. The best answer therefore is black scales and numbers on a white background, and a black pointer.

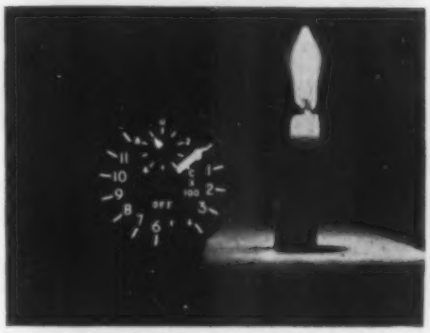
Light output at 60 cps is limited, since it varies with frequency. Life is long and failure is gradual, not catastrophic. A variety of colors are available but green and blue are best.

Operation is sensitive to temperature, particularly with plastic materials. Even with the ceramic materials, light

text continued, next page


High-intensity light directed forward to pointer
Plastic or glass diffuser
Plastic or glass scale
Pyramid molded into diffuser to act as mirrors
A


Front surface
Color filters can be cemented on at this point
Mounting shaft through center of pointer
Light source
Light path inside pointer
Mirror or diffusing surface
B



LIGHTED POINTERS present a special problem with black dials. Flat surfaces in the pyramidal recess in the plastic diffuser serve as mirrors (A) to reflect light forward to a diffusing hub (B) on the pointer. This is the method used to light the temperature indicator (C) and (D) to give spot intensities equal to a candle flame. (A flag, ordinarily retracted when instrument is energized, partly covers numerals 4 and 5.)

ILLUMINATION continued

TO MEASURE SPOT BRIGHTNESS

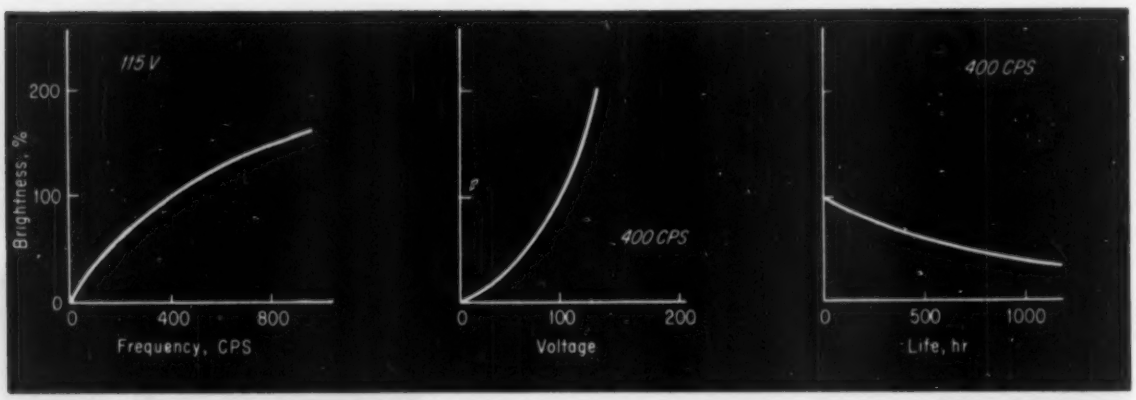
Magnifying optical system in the Brightness Spot Meter measures the light intensity of a spot 0.015 in. dia. Microammeter facing operator shows intensity directly in foot-lamberts.

In use, as shown on the cover of this issue, the instrument is mounted on a stand and adjusted until the spot to be measured is in optical focus as seen through the eyepiece at the rear of the instrument.

Optical system includes a beam-splitting mirror which reflects a portion of the beam down to a photomultiplier tube. Output of the tube is amplified and fed to a microammeter calibrated in foot-lamberts to indicate brightness. Amplifier ranges plus logarithmic scale on microammeter cover brightness ranges of 0.001 to 100,000 foot-lamberts. Selector switch in control panel on side provides magnification steps of 0.01 to 1000. A neutral-density filter brought into play by the knob on top reduces light intensity by 100 for an additional range of measurement.

Optical system has a ½-deg acceptance angle. With the microscopic lens attachment shown here, the field is reduced to 0.015 and the focus is ¾ in. Without the lens attachment the spot dia is approx ½ in. at the minimum focus of 5 ft; rotation of the focussing barrel extends the range to infinity. Other lenses permit focusing at ranges between ¾ in. and 5 ft.

Instrument shown here and on the front cover is Model UB-½ with microspectar lens, made by Photo Research Corp, Hollywood 38, Calif. The instrument was supplied by Hoffman Engineering Corp, Old Greenwich, Conn, for these PRODUCT ENGINEERING photographs. Power supply for the photometer tube is in a separate housing not shown.



FREQUENCY, VOLTAGE AND LIFE affect brightness of electroluminescent surfaces at room temperatures.

output and life both fall off when temperature rises above 120 F.

One interesting possibility with electroluminescent lighting is the opportunity to change scale color as certain critical indications are reached.

EDITOR'S NOTE: These earlier articles discuss instrument lighting problems, and the opportunities offered by area light sources.

Electroluminescence—New Area Light Source, Sep 15 '58, p 74—How this system produces light; effects of voltage and frequency on intensity; commercially available products and current applications.

Counters for Digital Display, May 16 '60, p 106—Advantages of digital over analog display; recommendations for readability.

How to Select Miniature Lamps, July 18 '60, p 57—New types and sizes available for built-in use; design guide to selection of type; illustration of new instrument using electroluminescent panel.

Three Criteria for Readable Panel Markings, May 25 '59, p 55—Best lettering for visibility and rapid scanning; also for legends and counters.

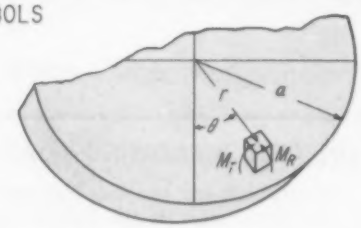
9 Ways to Make Instruments Readable, Feb 3 '58, p 61—Conditions that cause trouble in reading pointer indications, and how to avoid them; how to design scales and digits for fast reading; height-width ratio for readability.

Simplified equations find moments in circular plates

Resolving the forces in axially loaded circular plates—the ends of pressure tanks, for example—is normally a complex job. But with these tables and simplified equations, you can calculate bending moments at any point in a circular plate—whether load is uniformly distributed or increases linearly across the diameter.

ROBERT I ISAKOWER, *ordnance engineer, Picatinny Arsenal*

SYMBOLS



a = Radius of plate, in.

F_{R1}, F_{T1}, F_{R2}, F_{T2} = Position factors, functions of r/r and μ (see table)

M_R = Bending moment along circumferential section, in.-lb/in.

M_T = Bending moment along diametral section, in.-lb/in.

p_1 = Uniform pressure, psi

p_2 = Average varying pressure, (p max - p min)/2, psi

r = Radial polar coordinate of plate element, in.

θ = Angular polar coordinate of plate element measured from bottom of plate, radians

μ = Poisson's ratio for the plate material

In tanks and pressure vessels, circular plates quite frequently appear as load-bearing members—as ends for cylindrical tanks, as access plates, porthole covers, bulkheads or cleanout plates. But calculating the bending moments in such plates is not simple; this is why most of us settle for a quick approximation plus a generous factor of safety. A further complication is met when the load is not evenly distributed but varies from top to bottom of plate, as in the end plate for a horizontal cylindrical tank containing a liquid.

The following methods reduce the rigorous equations for such problems to simple expressions containing a lumped constant to be substituted from a table.

UNIFORM LOADING

The simplified equations for radial and tangential moments at any point in a uniformly loaded circular plate are

$$M_R = \frac{p_1 a^2 F_{R1}}{16}$$

$$M_T = \frac{p_1 a^2 F_{T1}}{16}$$

The constants F_{R1} and F_{T1} are called "position factors" because they are a function of the radial distance from the center of the plate, expressed as the ratio r/a. The equations apply only to circular plates with fixed ends

Position Factors

F_{R1}

r/a	μ = 0.25	= 0.3	= 0.4
0.0	1.2500	1.3000	1.4000
0.1	1.2175	1.2670	1.3660
0.2	1.1200	1.1680	1.2640
0.3	0.9575	1.0030	1.0940
0.4	0.7300	0.7720	0.8560
0.5	0.4375	0.4750	0.5500
0.6	0.0800	0.1120	0.1760
0.7	−0.3425	−0.3170	−0.2660
0.8	−0.8300	−0.8120	−0.7760
0.9	−1.3825	−1.3730	−1.3540
1.0	−2.0000	−2.0000	−2.0000

F_{T1}

r/a	μ = 0.25	= 0.3	= 0.4
0.0	1.2500	1.3000	1.4000
0.1	1.2325	1.2810	1.3780
0.2	1.1800	1.2240	1.3120
0.3	1.0925	1.1290	1.2020
0.4	0.9700	0.9960	1.0490
0.5	0.8125	0.8450	0.8500
0.6	0.6200	0.6160	0.6080
0.7	0.3925	0.3690	0.3220
0.8	0.1300	0.0840	−0.0080
0.9	−0.1675	−0.2390	−0.3820
1.0	−0.5000	−0.6000	−0.8000

F_{R2}

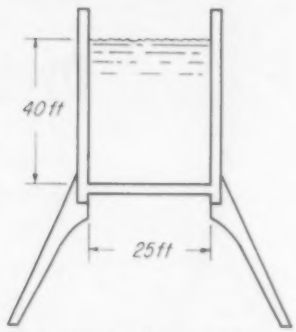
r/a	μ = 0.25	= 0.3	= 0.4
0.0	0	0	0
0.1	0.3197	0.3247	0.3346
0.2	0.6080	0.6176	0.6368
0.3	0.8332	0.8469	0.8742
0.4	0.9640	0.9808	1.0144
0.5	0.9687	0.9875	1.0250
0.6	0.8160	0.8352	0.8736
0.7	0.4742	0.4921	0.5278
0.8	−0.0880	−0.0736	−0.0448
0.9	−0.9023	−0.8937	−0.8766
1.0	−2.0000	−2.0000	−2.0000

F_{T2}

r/a	μ = 0.25	= 0.3	= 0.4
0.0	0	0	0
0.1	0.1727	0.1875	0.2170
0.2	0.3320	0.3600	0.4160
0.3	0.4642	0.5025	0.5790
0.4	0.5557	0.6000	0.6880
0.5	0.5937	0.6375	0.7250
0.6	0.5640	0.6000	0.6720
0.7	0.4532	0.4725	0.5110
0.8	0.2480	0.2400	0.2240
0.9	−0.0653	−0.1125	−0.2070
1.0	−0.5000	−0.6000	−0.8000

where both deflection and rotation of the plate at its periphery are assumed to be zero. In tanks and pressure vessels, this is normally the case. If the plate is a closure for the end of a cylindrical tank it is common practice to include a reinforcing ring, thus prohibiting movement at the edges. And cover plates are usually fastened with closely spaced, heavy-duty bolts that perform the same function.

EXAMPLE 1



An upright cylindrical tank, 25 ft diameter, is supported on a stand and filled with water to a depth of 40 ft. If the tank is made of steel ($\mu = 0.3$), what is the radial and tangential bending moment at the center of the tank bottom?

Solution: The water exerts a uniform pressure of 17.9 psi on the circular plate. From the table ($r/a = 0$, $\mu = 0.3$), position factors are $F_{R1} = 1.30$ and $F_{T1} = 1.30$

$$M_R = \frac{p_1 a^2 F_{R1}}{16}$$

$$= (17.9)\ (12.5 \times 12)^2\ (1.30)/16 = 32{,}800 \text{ in.-lb/in.}$$

$$M_T = \frac{p_1 a^2 F_{T1}}{16}$$

$$= (17.9)\ (12.5 \times 12)^2\ (1.30)/16 = 32{,}800 \text{ in.-lb/in.}$$

LINEARLY INCREASING LOAD

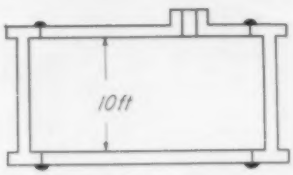
When a circular plate acts as a wall (or part of a wall) of a fluid container, pressure on the plate is not uniform but varies linearly from top to bottom of plate in either a triangular or trapezoidal fashion. One way to compute moments in such a plate is to assume a uniform pressure with a value equal to average pressure. It is more precise, however, to spit the pressure loading into two components: a uniform pressure, p_1, (with moments computed as before); and a varying pressure, p_2. The separation is made so that varying pressure is $+p_2$ at the bottom of the plate, $-p_2$ at top, and zero in center. The simplified moment equations for varying pressure applied to a circular plate with fixed ends are

$$M_R = \frac{p_2 a^2 F_{R2} \cos\theta}{48}$$

$$M_T = \frac{p_2 a^2 F_{T2} \cos\theta}{48}$$

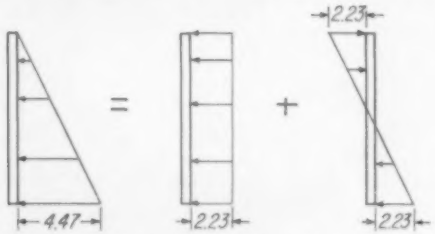
where p_2 is pressure at $\theta = 0°$ (bottom of plate).

EXAMPLE II



Flat circular plates cover the ends of a horizontal steel tank completely filled with water. Given: dia = 10 ft and $\mu = 0.3$ for steel, find bending moments at bottom of end plates.

Solution: Pressure on the end plates varies linearly from 0 psi at the top to 4.47 psi at the bottom. By superposition, this pressure distribution is divided into two different pressures, one uniform and one varying as shown below.



Uniform pressure $p_1 = 4.47/2 = 2.23$ psi, and radius $a = 10/2 = 5$ ft.

From the tables; since r/a = 1 and $\mu = 0.3$, $F_{R1} = -2.0$ and $F_{T1} = -0.06$.

$$M_R = \frac{p_1 a^2 F_{R1}}{16}$$
$$= 2.23\,(5 \times 12)^2\,(-2.0)/16 = -1004 \text{ in.-lb/in.}$$
$$M_T = \frac{p_1 a^2 F_{T1}}{16}$$
$$= 2.23\,(5 \times 12)^2\,(-0.6)/16 = -301 \text{ in.-lb/in.}$$

For varying pressure $p_2 = 2.23$ psi and $\cos\theta = \cos 0° = 1.0$ at bottom of plate.

From the tables, $F_{R2} = -2.0$ and $F_{T2} = -0.6$

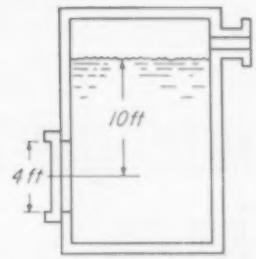
$$M_R = \frac{p_2 a^2 F_{R2} \cos\theta}{48}$$
$$= 2.23\,(5 \times 12)^2\,(-2.0)\,(1.0)/48 = -334 \text{ in.-lb/in.}$$
$$M_T = \frac{p_2 a^2 F_{T2} \cos\theta}{48}$$
$$= 2.23\,(5 \times 12)^2\,(-0.6)\,(1.0)/48 = -100 \text{ in.-lb/in.}$$

Combining to get total resultant moments,

$$M_R = (-1004) + (-334) = -1338 \text{ in.-lb/in.}$$
$$M_T = (-301) + (-100) = -401 \text{ in.-lb/in.}$$

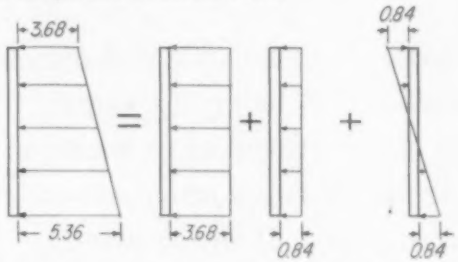
The negative sign indicates that the moments act in a direction opposite to the direction assumed by the sign convention chosen in deriving the equations. Notice that the chart shows that bending moments are positive at center of plate and negative at the edges.

EXAMPLE III



A steel standpipe has a 4-ft-dia access plate with centerline 10 ft below water level. Find bending moments at the top edge of the access plate, assuming $\mu = 0.3$.

Solution: Trapezoidal pressure distribution divides into three components as shown below.



Both components of uniform pressure loading combine into one so that $p_1 = 4.52$ psi.

$$M_R = \frac{p_1 a^2 F_{R1}}{16}$$
$$= 4.52\,(2 \times 12)^2\,(-2.0)/16 = -325 \text{ in.-lb/in.}$$
$$M_T = \frac{p_1 a^2 F_{T1}}{16}$$
$$M_T = 4.52\,(2 \times 12)^2\,(-0.6)/16 = -97.6 \text{ in.-lb/in.}$$

The component of varying pressure is $p_2 = 0.84$. Because it is desired to find the bending moment at the top of the plate, $\cos\theta = \cos 180° = -1.0$.

$$M_R = \frac{p_2 a^2 F_{R2} \cos\theta}{48}$$
$$= 0.84\,(2 \times 12)^2\,(-2.0)\,(-1.0)/48 = 20.2 \text{ in.-lb/in.}$$
$$M_T = \frac{p_2 a^2 F_{T2} \cos\theta}{48}$$
$$= 0.84\,(2 \times 12)^2\,(-0.6)\,(-1.0)/48 = 6.05 \text{ in.-lb/in.}$$

Total resultant moments are

$$M_R = (-325) + (20.2) = -304.8$$
$$M_T = (-97.6) + (6.05) = -91.55$$

EDITOR'S NOTE: Other recent articles relating to the design of pressure vessels are listed below.

Maximum Compressive Stress for Annular Plates, Mar 14 '60, p 77—charts and nomogram find buckling stress for rings loaded in uniform, radial compression.

Use Reinforcing Rings on Pressure Cylinders, June 6 '60, p 53—simple formulas compute stress in reinforcing rings.

When Thin-wall Cylinders Carry the Load, May 23 '60, p 61—new equations give quick answer for stress and deflection caused by skirts and reinforcing rings.

Stress in Flat-ended Pressure Cylinders, Dec 8 '58, p 111—two charts and simple formulas find max stress.

MECHANIZED TUTORS join the teaching profession

Mechanical, electronic and optical equipment is being developed that offers a speedup in training methods. Here's a progress report and summary of the growing activity in this new field.

LEWIS H YOUNG, *associate editor*
Control Engineering Magazine
McGraw-Hill Publishing Co Inc

TEACHING SERVICE PERSONNEL is one of the jobs done better by machine. The viewing screen here displays lessons from a microfilm file. If student pushes buttons for a wrong answer, he is shown review material, hints, etc.; when answer is correct, next lesson appears on screen. In either case, the machine's immediate response speeds learning by shortening "reinforcement time." This device, called Autotutor, is made by Western Design Div, US Industries Inc.

Machines that teach—actually instruct the student in tutor fashion—are speeding up training in schools and industry. Some early tests show that automated teaching can cut training time as much as 50%. This is made possible by a new approach to the problem: subject matter is divided into small, logically connected pieces and the student's understanding of each piece is checked by questioning him immediately after he has read each lesson. The automatic teaching machine mechanizes the psychological principle of "reinforcement": the student's grip on a new fact is strengthened by prompt acknowledgement of his answer.

The idea is nearly six years old but has only recently begun to win wide approval. Most of the machinery has been developed only within the past two years and much of the expansion has occurred only in the last six months.

Unlike previous teaching aids, the new tutors can teach a broad range of subjects in areas that psychologists classify as symbolic skills—non-manual skills such as mathematics, logic, language, psychology, even philosophy. In the schoolroom, machines will probably never fully replace the teachers, who will still be needed for broader education and for counseling. But some forms of industrial instructions can be completely mechanized. For example, teaching-machine proponents point to five areas where the automated devices will probably be seen within the next 10 years.

- Keeping engineers up to date with technical advances in their field of specialization.
- Training field-service personnel, particularly those who maintain complex equipment such as electronic computers.
- Training computer programers.
- Teaching clerks in such jobs as data-processing procedures and other paperwork-handling positions that have high turnover.
- Teaching foremen and methods-men how to use new automatic production techniques.
- Training key-punch operators.

Main advantage of the mechanical tutors is their ability to give fast "reinforcement." Psychologists have found speed of learning to be a direct function of the delay between time the student answers a question and time the answer is acknowledged. The longer the delay, the

longer it takes him to learn. The ideal reinforcement time is ½ second, according to Eugene Galanter, a psychologist at the University of Pennsylvania. Ten times as many trials are needed to learn something if reinforcement time is stretched to 10 seconds and 100 times as many trials when the delay is as long as a minute. With a machine, learning speed is increased because the machine reinforces the student immediately after his answer. One example of what this can mean: In a trial at Roanoke, Va, an 8th-grade, machine-taught class completed a full-year, 9th-grade algebra course in just half a year.

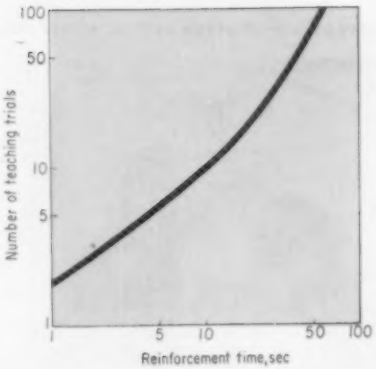
Not all these new teaching devices are actually machines. Some are simply a programed presentation like the 1000-page looseleaf notebooks prepared by Encyclopedia Britannica Films. Others are in the form of an unusually written, curiously arranged text book. Regardless of form, all these teaching aids work the same way. They expose the student to a brief explanation, then check his understanding of that point by asking him to make some kind of response. If his response is wrong, he is instructed to reread the material and try again.

The Hardware

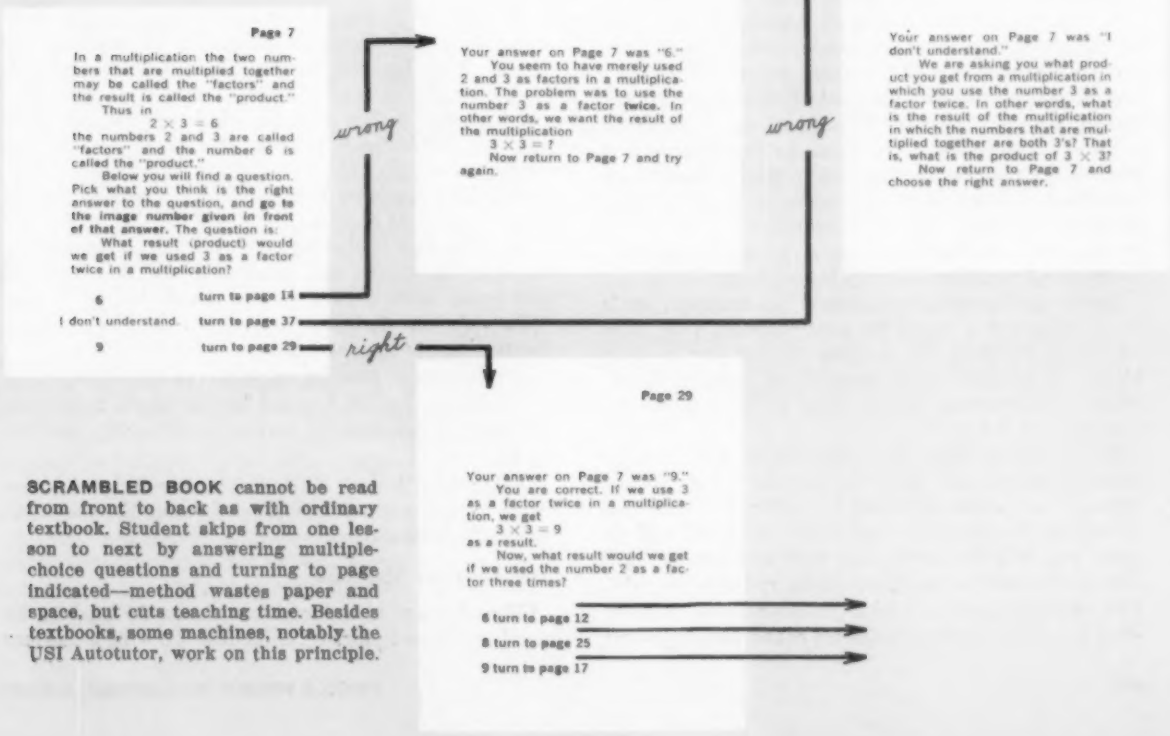
The first teaching machine (actually an automatic intelligence tester) was built in 1926 by Dr Sidney L. Pressey, then at Ohio State University. But Pressey's machine never impressed educators and died a cultural death in 1932.

The idea was revived in 1954 by Dr B. F. Skinner, a Harvard psychologist whose experiments with conditioned operant behavior (an area of psychology that covers the learning mechanism) led him to the conclusion that then-current teaching methods were far from optimum. His experiments, in fact, convinced him that educators were moving in the wrong direction. To prove his point he built a simple machine; when it worked, it started the industry on its present boom.

Skinner's approach has since been incorporated in a simple commercial machine known as the Recall–perhaps best known of the present designs. It requires the student to read a short lesson in one window and write



SHORT REINFORCEMENT TIME (telling the student quickly whether he answered correctly) is the key to fast instruction. With conventional teaching, many trials are required for the student to learn the lesson. Machine cuts reinforcement time and thus, number of trials.


Page 7
In a multiplication the two numbers that are multiplied together may be called the "factors" and the result is called the "product."
Thus in
2 × 3 = 6
the numbers 2 and 3 are called "factors" and the number 6 is called the "product."
Below you will find a question. Pick what you think is the right answer to the question, and go to the image number given in front of that answer. The question is:
What result (product) would we get if we used 3 as a factor twice in a multiplication?
6 turn to page 14
I don't understand. turn to page 37
9 turn to page 29
wrong
Page 14
Your answer on Page 7 was "6."
You seem to have merely used 2 and 3 as factors in a multiplication. The problem was to use the number 3 as a factor twice. In other words, we want the result of the multiplication
3 × 3 = ?
Now return to Page 7 and try again.
wrong
Page 37
Your answer on Page 7 was "I don't understand."
We are asking you what product you get from a multiplication in which you use the number 3 as a factor twice. In other words, what is the result of the multiplication in which the numbers that are multiplied together are both 3's? That is, what is the product of 3 × 3?
Now return to Page 7 and choose the right answer.
right
Page 29
Your answer on Page 7 was "9."
You are correct. If we use 3 as a factor twice in a multiplication, we get
3 × 3 = 9
as a result.
Now, what result would we get if we used the number 2 as a factor three times?
6 turn to page 12
8 turn to page 25
9 turn to page 17

SCRAMBLED BOOK cannot be read from front to back as with ordinary textbook. Student skips from one lesson to next by answering multiple-choice questions and turning to page indicated—method wastes paper and space, but cuts teaching time. Besides textbooks, some machines, notably the USI Autotutor, work on this principle.

TOMORROW'S CLASSROOM—COMPUTERS AND NO HOMEWORK

Because faster reinforcement time appears such a key factor in reducing teaching time, psychologists are beginning to question the value of one of education's most cherished traditions—homework. Reinforcement of homework assignments is always postponed at least a day. With this much delay it is unlikely that homework contributes much, if anything, to learning.

With this emphasis on direct-response study and with development of more sophisticated teaching machines, some researchers predict that someday every school will have a central teaching computer. Its memory will contain programs for all courses and each program will allow for variation in learning time of students. But this system is a long way off—a minimum of 5 to 7 years, according to most estimates.

◀**CLASSROOM OF THE FUTURE** may look like this if experiments continue to be encouraging. Photo shows teaching booths at Hamilton College, where machines have cut a 3-hour-a-week logic course to 2 hours a week—and cover more material. Average grade has gone from 65 to 86; failures, normally 10% of class, have been eliminated.

the answer in another window. Its operation is strictly mechanical and cost is about $200. A somewhat similar machine has been built by Hamilton Research Associates.

While some psychologists say that a written response is not necessary, Prof Skinner claims learning does not stem from simply making a choice: "We want the student to recall rather than recognize because recall is deeper than recognition."

He suggests that the multiple-choice questions asked by some machines are likely to introduce erroneous information at the worst possible time in a student's learning cycle. If a student chooses one of the plausible, but incorrect, answers to a multiple choice question, sometime later he may remember the inaccuracy as something he read and believe it is correct.

Defenders of multiple choice claim faster reinforcement—thus faster learning—because it takes only a moment for the student to select his answer and check it. Says one psychologist, "In the learning process, choosing a correct answer is adequate because all that it necessary is that the student understand the choice."

There are probably applications for both approaches The written response may be best to teach subjects such as medical anatomy where the student either knows the answer or he doesn't. For those subjects with a more logical foundation, such as mathematics and trouble shooting, multiple-choice techniques may be satisfactory.

Of the multiple-choice machines, the Autotutor made by US Industries is one of the most elaborate. It is about the size of an office desk standing on end; cost is about $4000. Its program is on microfilm—as many as 10,000 frames of information can be stored in the machine for projection on the screen.

To use this machine, the student begins with the first frame in the program, reads the material (or studies the drawings) and selects an answer by pushing a combination of buttons. This triggers a new frame of microfilm which either tells him his answer was right and presents new information, or calls the answer wrong and tells him why. This type of program is called a "scrambled book" because, when bound as a book, it sends the reader skipping about instead of reading successive pages (see example on preceding page). USI has just completed a tabletop model of its Autotutor, which can hold 1000 frames and will cost about $1000.

A much simpler multiple-choice coach is the Tutor built by General Atronics to cost about $200. This machine has the program on individual cards which have diecut tabs positioned in one of four locations. There are four keys on the machine and the tab on any particular card has been cut so that it is in contact with the key representing the correct answer. The student reads one card at a time, that card being held in the viewing position by its tab and corresponding key. When his chosen answer is correct, the card drops out of sight, and the next card is revealed. If he is wrong, nothing happens.

Research at Systems Development Corp typifies work being done with electronic computers for teaching machines. SDC has programed a Bendix G-15 general-purpose computer to teach English composition. The computer controls a slide projector which projects one block of the multiple-choice program at a time. The student responds by typing his answer on an alpha-numeric keyboard. The computer then prints out a message telling him if he is right or wrong.

Big advantage of the computer, say SDC researchers, is its flexibility—it can add information for slow students and bypass items the fast student already knows. It now trains only one student at a time, but SDC is preparing the machine to train as many as 18 simultaneously.

Special-purpose teaching machines are also in the works.

- Solartron Ltd of England has developed a machine for training operators to keypunch accounting machine cards.
- Robodyne Div of US Industries has designed a machine to train post office employes in using the new semi-automatic letter-sorters.

The Program Shortage

Though many of the machines are on the market, the number of tested programs is limited. To write a program

WRITTEN-RESPONSE, rather than multiple-choice answer, is method of Recall machine built and designed by Rheem Califone Corp. It is a relatively simple device. Two large cranks control motion of two tapes. Text and questions are on program tape viewed, one block at a time, through window at left; student writes answer on blank tape in window at right, then rolls it up under a transparent plastic shield in upper half of answer window where it can be seen but not changed. Now he pushes lever at lower left to uncover correct answer under black shield.

takes a combination of a psychologist and an expert in the field to be programed. One company estimates a cost of $20,000 to write and test a program, starting from scratch.

The most ambitious program-writing project in the US has just been started by Encyclopedia Britannica Films. These will be of the written-response type. A group of mathematicians, under the direction of Hollins College psychologist Allen Calvin, is programing seven mathematics courses, from highschool algebra to a college course in differential equations. When this project is complete, EBF will program 12 language courses as well as courses in biology, physics, and chemistry and then proceed to elementary-school subjects. A research center is under construction at Roanoke for writing and testing the programs.

Hamilton Research Associates (a company formed to market the products of Hamilton College research) has programs for a written-response teaching machine covering courses in logic, algebra, and how to read a micrometer. HRA is also trying to commission experts to write programs in their specialities. The company will convert these to microfilm, distribute them to users, and pay the authors royalties.

General Atronics in Philadelphia is also interested in commissioning authors, but for multiple-choice programs. It has come up with a programed textbook. So far, GA has only one program available: a course in how to read Russian.

Most active in the writing of multiple-choice programs is US Industries. These programs will be published as scrambled books by Doubleday and Co under the tradename Tutor-Texts. USI will introduce four programs this month: "The Elements of Bridge," "The Arithmetic of Computers," "Adventures in Algebra," and "Introduction to Electronics." In a controlled test the latter is being taught on the USI AutoTutor to Air Force cadets at Keesler Air Force Base. Eighteen cadets are taking the course; another 18 will study in a conventional manner, with teachers and lectures. If the Tutor-Texts are well received, Doubleday plans to publish one a month next year.

Because program preparation and testing is so expensive, many of the experiments have been conducted at colleges, and financed by foundations. Here is some of the activity:

- At Harvard, Skinner has supervised the programing of beginning arithmetic, a course in vocabulary-stretching for 7th-grade students, and a college psychology course in human behavior.
- At Oberlin College, a group is programing psychology, genetics, music, logic, and mathematics. This is financed by a grant from the Ford Foundation.
- The Deveraux Foundation in Devon, Penna has a spelling program for elementary-school children.
- At Hamilton College, psychologist John Blyth has programed five elementary courses and has begun to program French, German, psychology and philosophy. ■

how to select the right gasket material

This 4-step procedure puts design emphasis where it belongs—on the total bolt force applied to the joint at time of installation.

J J WHALEN, *staff engineer, Johns-Manville Corp, NYC*

Three main design factors govern the selection of a gasket material—whether sheet packing, metal, or a combination of materials. The factors are:

Fluid compatibility at the pressure-temperature condition being designed for must be checked first. A recent survey of the technical literature from reliable packing manufacturers indicates a sufficiency of such information. You should collect these publications, file them, and keep them up-to-date.

Pressure-temperature combination determines whether the gasket material is inherently strong enough to resist blow-out. One rule-of-thumb criterion is the product of operating pressure P_i and operating temperature T. Table I lists maximum values of $P_i \times T$ for several basic types of gasket material. These figures are based on experience, test data, and analysis of current technical literature.

Total bolt force at installation must be sufficient to: (1) flow the gasket surface into the flange surface to make an effective seal; (2) prevent the internal pressure from opening the flanges. This demands carefully juggling gasket material, seating area, bolt selection, and flange-surface finish. Here is a logical way to achieve the right balance among these factors for the majority of gasket joint problems.

1. CALCULATE THE TOTAL BOLT FORCE

Fig 1 shows forces and stresses at work in a typical gasketed joint. Total force F_b required to generate the proper gasket-seating stress is not a design value; it is determined at installation. The problem at design stage is to calculate it by the method that will come closest to conditions at installation. There are three such calculation methods, each with certain advantages and limitations:

Bolt-torque method is based on using a torque wrench or impact wrench at installation. Knowing the installation bolt-torque T, total bolt force is calculated from the following empirical equation:

$$F_b = N_b T / 0.2 D_b \qquad (1)$$

The number of bolts N_b and their diameter D_b are either known or are assumed, subject to later adjustment for adequate sealing stress or resistance to internal pressure force. Remember that torque-wrench readings are only accurate to ± 25% because of variations in bolt lubrication, fit, and surface finish. Impact wrenches are more accurate, but manufacturers should be consulted as to how much torque is applied to a given bolt at a given setting.

Estimation method is used if the flanged joint is to be made by standard wrenches and with little control over qualifications of the mechanic. The following is an old rule-of-thumb relation based on investigations of bolt tension in steamtight fittings,

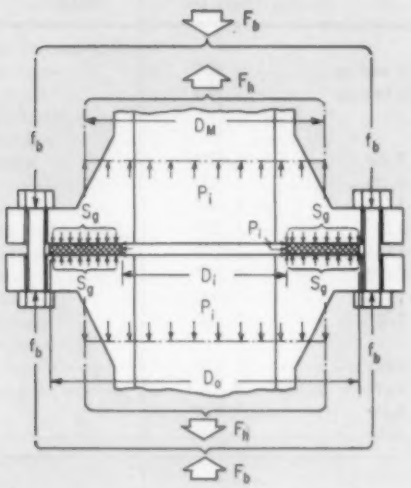
$$F_b = 16{,}000 D_b N_b \qquad (2)$$

and is limited largely to flange systems using alloy steel bolts.

Bolt-stress method is the most precise; it takes into account the bolt material and the thread series specified. The equation is:

$$F_b = N_b S_b A_b \qquad (3)$$

MECHANICS OF A GASKETED JOINT



LIST OF SYMBOLS

N_b	Number of bolts
P_i	Operating pressure, psi
P_t	Test pressure, psi
T	Bolt torque, in.-lb
f_b	Force per bolt, lb
F_b	Total bolt force, lb
F_h	Hydrostatic end force, lb
D_i	Gasket ID, in.
D_o	Gasket OD, in.
D_b	Nominal bolt diameter, in.
D_m	Gasket mid-diameter, in.
A_g	Gasket contact area, sq in.
A_m	Area subject to pressure P_i
A_b	Stress area per bolt, sq in.
S_g	Gasket seating stress, psi
S_b	Bolt stress, psi
K	Safety factor, dimensionless

Here, you decide what maximum bolt stress S_b is to be tolerated for the bolt material selected, then pick out the bolt-stress area A_b from Table II for the thread series used. Note that stress area (and hence bolt force) can differ as much as 10% between thread series. This stress area, the latest ASA standard (B1.1-1960), is somewhat larger than the conventional root-diameter area. For convenience in multiple calculations, Table II can be converted to a table of bolt forces simply by multiplying the stress areas, in turn, by a series of stress values—say 10, 20, 30, 45, and 60 kips per sq in.

After the assumption of bolt stress S_b is made, a bolt torque must be specified to ensure that this stress is approximated at installation. Correct torque is calculated by transposing Eq (1) in terms of stress:

$$T = 0.2 D_b S_b A_b \qquad (4)$$

The stress S_b used in Eq (3) and (4) is a matter of judgment. Most common figure for carbon- and stainless-steel bolts is a stress just below yield strength of the bolt material. For alloy-steel bolts, the yield strength is difficult to approach at installation. For these, practical S_b values may be estimated from Eq (2) and the stress area from Table II.

Hydraulically operated bolt tensioners provide an accurate way of ensuring proper bolt loading. Essentially a jack, the tensioner has a pulling rod equipped with a threaded adapter for the bolt at one end, and a piston at the other. Oil pressure is admitted to the tensioner housing, which is designed to carry the compressive reaction to the flange. With the bolt preloaded to proper tension, the nut is spun down and oil pressure released. Commercial accuracy is ± 10%, much better than preloading with torque wrenches or bolt heaters. Main disadvantage is extra cost of tensioners—3 required for uniform closure. (For more details see PE—Sept 19, p 75.)

text continued, next page

TABLE I—PRESSURE-TEMPERATURE VALUE FOR GASKET MATERIALS

Material	Max $P_i \times T$	Max Temp, °F
Rubber	15,000	300
Vegetable fiber	40,000	250
Rubberized cloth	125,000	400
Compressed asbestos	250,000	850
Metal types	>250,000	depends on metal

Table II—STRESS AREAS FOR FLANGE BOLTS

Nominal dia, in	Coarse Threads: Threads per in	Coarse Threads: Stress area, sq in	Fine Threads: Threads per in	Fine Threads: Stress area, sq in
0.125 (No. 5)	40	0.0079	44	0.0082
0.138 (No. 6)	32	0.0090	40	0.0101
0.164 (No. 8)	32	0.0139	36	0.0146
0.190 (No. 10)	24	0.0174	32	0.0199
0.216 (No. 12)	24	0.0240	28	0.0257
1/4	20	0.0317	28	0.0362
5/16	18	0.0522	24	0.0579
3/8	16	0.0773	24	0.0876
7/16	14	0.1060	20	0.1185
1/2	13	0.1416	20	0.1597
1/2	12	0.1374		
9/16	12	0.1816	18	0.2026
5/8	11	0.2256	18	0.2555
3/4	10	0.3340	16	0.3724
7/8	9	0.4612	14	0.5088
1	8	0.6051	12	0.6624
1 1/8	7	0.7627	12	0.8549
1 1/4	7	0.9684	12	1.0721
1 3/8	6	1.1538	12	1.3137
1 1/2	6	1.4041	12	1.5799

how to select the right gasket material

continued

Table III—MINIMUM SEATING STRESSES FOR TYPICAL GASKET MATERIALS

	Material	Type (see Table IV)	Thickness, in.	Minimum seating stress, psi	Flange-surface finish 1st choice	Flange-surface finish 2nd choice
NONMETAL	**Rubber sheet**					
	SBR (75 Durometer)	Flat	1/32 and up	200		
	CR (60 Durometer)	Flat	1/32 and up	175		
	Compressed asbestos					
	SBR binder	Flat	1/64	3,000		
			1/32	2,000		
			1/16	1,600		
			1/8	1,200	Concentric-serrated	All other types
	CR binder	Flat	1/64	3,750		
			1/32	2,500		
			1/16	2,000		
			1/8	1,500		
	Rubberized cloth	Folded	2-ply	2,500		
			3-ply	2,100		
			4-ply	1,800		
	Vegetable-fiber sheet	Flat	all	750		
	Fluorocarbon (TFE)					
	Virgin	Flat	1/64	14,000		
			1/32	6,500		
			1/16	3,700	80 rms (1/64 in. only)	All other types
			1/8	1,600		
	Glass-filled	Flat	1/64	14,000	Concentric-serrated (all other thicknesses)	
			1/32	11,000		
			1/16	6,000		
			1/8	3,000		
	Asbestos cloth (impreg.)	Flat	3/32	1,600		
METAL	**Flat metals**					
	Aluminum	Flat	1/32	20,000		
	Copper		and	45,000	Concentric-serrated	80 rms or less
	Carbon steel		1/16	68,750		
	Monel			81,250		
	Stainless			93,750		
	Stamped metals					
	Lead			500		
	Aluminum			1,000		
	Copper	Corrugated	9/64	2,500		
	Carbon steel	jacket-metal	only	3,500		
	Monel			4,500		
	Stainless	filler		6,000	80 rms or less	150 to 200 rms
	Machined metals					
	Aluminum	Profile	All	25,000		
	Copper	(1/8-in. pitch)	thicknesses	35,000		
	Carbon steel			55,000		
	Monel			65,000		
	Stainless			75,000		

2. *SELECT A MATERIAL THAT WILL SEAT*

The total bolt force F_b calculated in step 1 must be enough to seat the gasket into the flange. In most cases, gasket geometry is fixed by the design, and gasket ID and OD are known. If not, they can be assumed and a tentative gasket area A_g computed—to be adjusted later as balanced design dictates. The actual compressive stress available to seat the gasket is then:

$$S_g = F_b/A_g \qquad (5)$$

Next, select a gasket material that will seat satisfactorily under this stress. Check through Table III for materials that have minimum seating stresses equal to or less than the available stress computed in Eq (5). The available stress can be as much as four times higher than the Table III value without overcompressing that gasket material.

continued on p 56

Table III—*continued*

	Material	Type (see Table IV)	Thickness, in.	Minimum seating stress, psi	Flange-surface finish 1st choice	Flange-surface finish 2nd choice
	Metal (asbestos-filler)					
	Aluminum	Corrugated and corded	1/8 only	2,000	150 to 200 rms	Concentric-serrated
	Copper			2,500		
	Carbon steel			3,000		
	Stainless			3,500		
	Monel			4,000		
METAL-ASBESTOS	Lead	Plain metal jacket	1/8 only	500		
	Aluminum			2,500		
	Copper			4,000		
	Carbon steel			6,000		
	Nickel			6,000		
	Monel			7,500		
	Stainless			10,000	80 rms or less	150 to 200 rms
	Same as stamped metals	Corrugated jacket	Same as for stamped metals			
	Stainless	Spiral-wound	0.125 and 0.175	3,000 to 30,000		

Table IV—TYPICAL GASKET CROSS-SECTIONS

Type (see Table I)	Cross-section	Description
Flat		Simplest gasket form; available in wide variety of materials for different conditions of fluid media, temperature and pressure; most easily manufactured for nonsymmetrical shapes.
Folded		Fabric-based gaskets especially designed for extremely rough and wavy flanges with low bolting loads.
Plain metal jacket		Asbestos filler enclosed partially or totally by metal jacket; combines easy compression with resistance to high pressure. Temperature resistance depends on jacket material chosen.
Corrugated jacket: **metal-filled** **asbestos-filled**		Corrugated metal or asbestos core enclosed by a corrugated-metal jacket and top washer. Better than flat gaskets for rough flanges—corrugations give greater resilience.
Corrugated and corded		Deeply corrugated metal with twisted asbestos cord cemented into the corrugations on both faces; aluminized for non-sticking. Well-suited to rough or warped flanges.
Profile		Heavy solid metal with concentric V-shape contact ridges that provide multiple seating surfaces. Each ridge is 0.010 in. wide. For N ridges, effective area is then: $\pi \times$ mean contact dia $\times$ 0.010 $\times$ N. Seating stress increases with decrease in pitch.
Spiral-wound		Interlocked plies of preformed metal strip are spiral-wound with an interleaving cushion of asbestos or fluorocarbon plastic strip. Ratio of metal to filler can be closely controlled to vary seating stress over wide range. Well suited to fluctuating-temperature applications.

However, if the available stress is less than the tabulated minimum, the total bolt force must be increased or the gasket area reduced. Or a different type of gasket may be required. For best seating, select the thinnest gasket consistent with flange flatness and parallelism.

Questions of fluid compatibility and $P_i \times T$ combination will have been checked at the outset. Table III does not show all available gasket types, so search technical literature for minimum seating stresses for other materials, as well as new ones that appear.

3. CHECK THE HYDROSTATIC END FORCE

Total bolt force must be more than enough to overcome hydrostatic end force—defined here as the product of the internal pressure and a mean internal area A_m. Extensive testing shows that, just prior to leakage, internal pressure acts up to the mid-diameter of the gasket. The internal pressure used for this calculation must always be the test pressure P_t, not the operating pressure P_i. Thus, for balance,

$$F_b \geq K P_t A_m \qquad (6)$$

Where K is a safety factor selected to fit particular design conditions, as indicated in Table V.

4. SPECIFY THE FLANGE-SURFACE FINISH

Once the statics of the gasket joint have been resolved and an appropriate gasket material selected, pay close attention to flange-surface finish. Table II shows the preferred finish for each material, plus a second choice. A concentric-serrated surface is one machined with 90° V-grooves $\frac{1}{64}$ in. deep on a $\frac{1}{32}$-in. pitch. Machining concentrically requires special tools and techniques, but gives multiple sealing lands as compared to the continuous exit path provided by conventional spiral machining. A third choice: spiral-serrated flanges will usually work satisfactorily on spiral-wound gaskets or sheet packing—materials that flow easily.

REPRINT COPIES of this report are available for 25 cents each by addressing Reader Service Dept., Product Engineering, 330 W 42nd St, New York 36, N. Y.

EDITOR'S NOTE: Other recent articles on gaskets and seals, particularly for unusual and extreme operating conditions, include the following:

High-temperature Static Seals From Metal Fiber Composites, May 30 '60, p 57—Impregnating metal felt with compatible soft metal gives unusual material that will seal 5000-psi air at 1000 F.

The In-place Seal, Apr 18 '60, p 68—An offshoot of the O-ring. Article gives a guide to typical materials, compares in-place seals, gaskets, and O-rings.

How Gaskets Behave, May 25 '59, p 40—Latest research shows the way typical gasket materials behave in steel-aluminum flanged joints cycled to 300 F.

The Latest on Silicone Rubber Sponge, Aug 4 '58, p 54—Now, with better sponging grades, sharper process control, and special reinforcing techniques—tolerances can be predicted and rejects cut for this hi-temp sealing material.

Gaskets That Are Sprayed On, Oct 14 '57, p 90—Describes a technique of sprayed-aluminum gaskets for large-flanged openings in tanks, bulkheads, and piping.

How to Apply O-rings, Aug '57, p 176—Shows how selection of O-rings depends on physical and dimensional characteristics of the application.

Four Types of Synthetic Fiber Felt, July '57, p 178—Gives mechanical and chemical properties; how they relate to effectiveness as seals and gaskets.

Gasketed Joints for Electrical Equipment, Mar '57, p 183—Comparison of 8 common material types, 18 basic joining designs.

Rotating Seals for High Pressure, Feb '56, p 140—Effect of hydraulic balance, structural design, packing and seal face materials on selection of mechanical seals; how to control flow and pressure distribution.

Table V—SAFETY FACTORS FOR GASKETED JOINTS

K-factor	When to Apply
1.2 to 1.4	For minimum-weight applications where all installation factors (bolt lubrication, tension, parallel seating, etc.) are carefully controlled; low-temperature applications; where adequate proof pressure is applied.
1.5 to 2.5	For most normal designs where weight is not a major factor, vibration is moderate, and temperatures do not exceed 700 to 800 F. Use high end of range where bolts are not lubricated.
2.6 to 4.0	For cases of extreme fluctuations in pressure, temperature or vibration; where no test pressure is applied, or where uniform bolt tension is difficult to ensure.

SAMPLE PROBLEM

A gasket is needed to seal industrial hydraulic fluid at 1200 psi and 180 F. Flanges are 1½-in., raised-face, 600-lb weld-neck type made from Type 304 stainless steel. There are four bolts, ¾ in.–10 NC, made from ASTM-A193 grade B7 alloy steel. Hydrotest pressure is specified as 2.5 times operating pressure.

1. Total bolt force. Assuming torque wrenches will check installation, select bolt-stress method to calculate total bolt force. From Table II, stress area for ¾–10NC bolt is 0.3340 sq. in. Bolt material specified can easily take 30,000 psi without yielding (Eq 2 gives: 16,000 × 0.75/0.3340 = 36,000) thus from Eq (3):

$$F_b = 4 \times 30{,}000 \times 0.3340$$
$$F_b = 40{,}080 \text{ lb}$$

Torque required to produce this stress level at installation comes from Eq (4):

$$T = 0.2 \times 0.75 \times 30{,}000 \times 0.3340/12$$
$$T = 125 \text{ ft-lb (to be specified on print)}$$

2. Gasket-material selection: The $P_i \times T$ relation is 1200 × 180 = 216,000 which, from Table I, suggests choosing compressed asbestos type. This would be compatible with hydraulic fluid. Gasket area is 4.73 sq in., calculated from OD of $2\frac{7}{8}$ in. (same as OD of raised flange, per ASA–B16.5) and ID of 1½ in. Thus seating stress available is calculated from Eq (5):

$$S_g = 40{,}080/4.73$$
$$S_g = 8470 \text{ psi}$$

Table III shows this stress will easily seat selected compressed asbestos gasket. Tentatively choose asbestos with CR (neoprene) binder for oil resistance; thickness, $\frac{1}{32}$ in.

3. Hydrostatic end force: Mean area acted upon by pressure is defined by a diameter of $(2\frac{7}{8} + 1\frac{1}{2})/2$ and computes to 3.74 sq in. Selecting a safety factor of 1.5 from Table V, the end force is calculated and balanced against total bolt force by Eq (6):

$$40{,}080 \geq 1.5 \times 2.5 \times 1200 \times 3.74$$
$$40{,}080 \text{ lb} \geq 16{,}830 \text{ lb}$$

Thus there is no end-force balance problem with bolts stressed to 30,000 psi.

4. Surface finish: Table III shows a concentric-serrated surface finish on the flange is best. Economy may dictate a conventional spirel-serrated surface, which Table III shows will work in this case.

5. Final specification: Include not only material type and dimensions, but also the bolt-torque value calculated in step 1. For greater torque-wrench accuracy, specify uniform fit on all bolts and lubrication before installation.

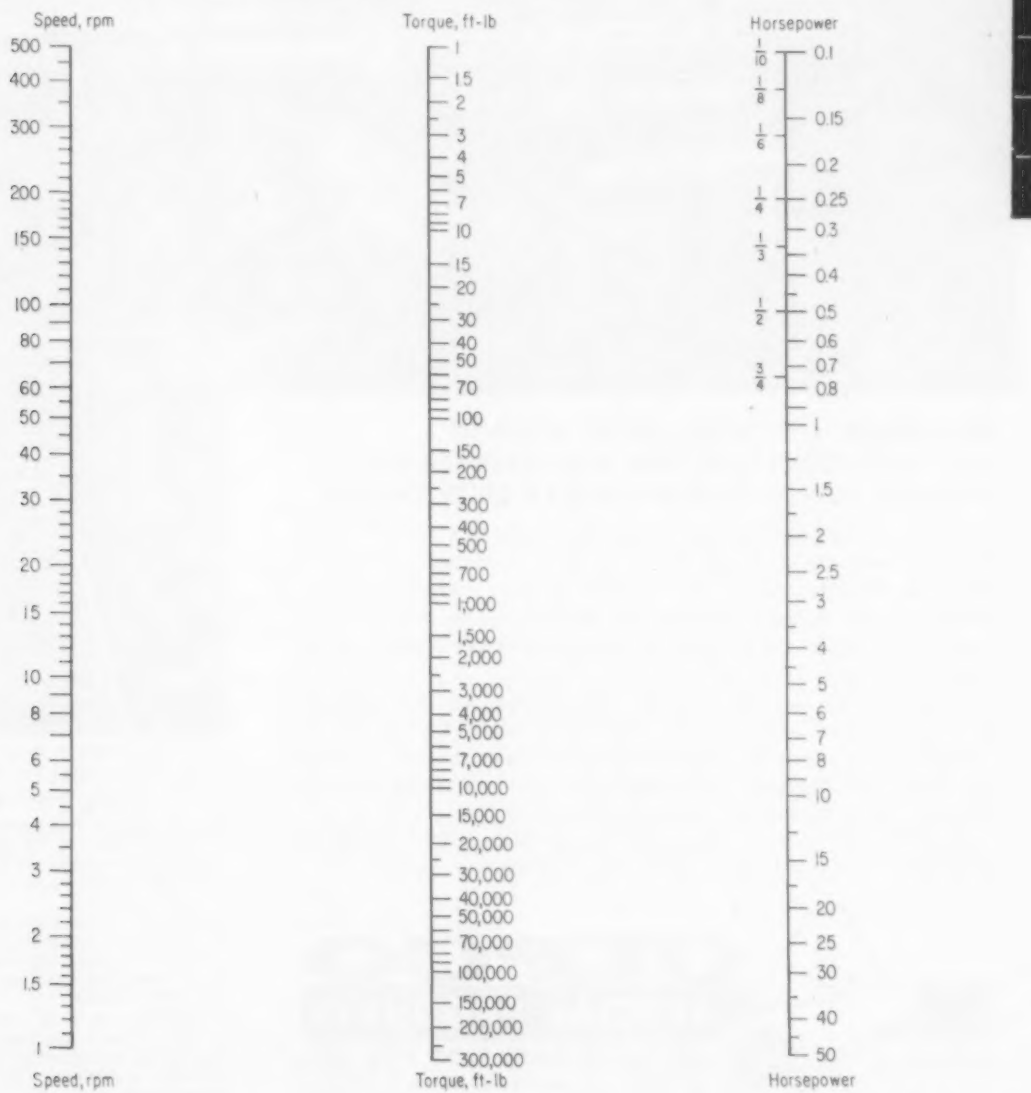
MOTOR HORSEPOWER at a glance

Nomographs give quick solutions to the familiar equation $hp = rpm \times torque/5252$.

SAMUEL HELLER, *chief engineer*
American Rectifier Corp, NYC

These two handy charts make it easy to compare several possible solutions when selecting motors. Values can be read directly off the scales; there is no need to work problems twice—once for the digits, and another time to find the correct decimal place —as is necessary with a slide rule.

For greater accuracy one nomograph covers the lower values of speed and torque; the other, the higher values.



continued on page 59

HOW ACIPCO HELPS CANADAIR KEEP 'EM FLYING

HYDRAULIC CYLINDER JACKS USED IN AIRCRAFT CONSTRUCTION AND MAINTENANCE EMPLOY ACIPCO CENTRIFUGALLY SPUN TUBING

The 10-ton hydraulic wing jack shown here is one of a number of different capacity jacks utilized by Canadair in its aircraft plants near Montreal. The hydraulic cylinders of these jacks are ACIPCO centrifugally spun tubing . . . and the manufacturers were supplied with Type 4130 normalized and tempered tubing in a variety of sizes ranging from 6½" O.D. to 11½" O.D.

"You may like to know, your material met our rigid specifications in every respect," wrote the manufacturer to ACIPCO, "and its excellent quality is such that the cylinders will render satisfactory, trouble-free service. The exceptional machinability of your tubing proved a definite asset in the manufacture of our cylinders."

ACIPCO tubing serves thousands of applications in hundreds of industries . . . economically . . . efficiently. May we serve you?

ACIPCO
SPECIAL PRODUCTS
DIVISION OF AMERICAN CAST IRON PIPE CO.
BIRMINGHAM 2, ALABAMA

VERSATILE ACIPCO CENTRIFUGALLY SPUN STEEL TUBES

SIZE RANGES: Tubes are produced in lengths from 4' to 20'; longer lengths are made by welding. O.D.'s from 2.25" to 50"—wall thicknesses from .25" to 8".

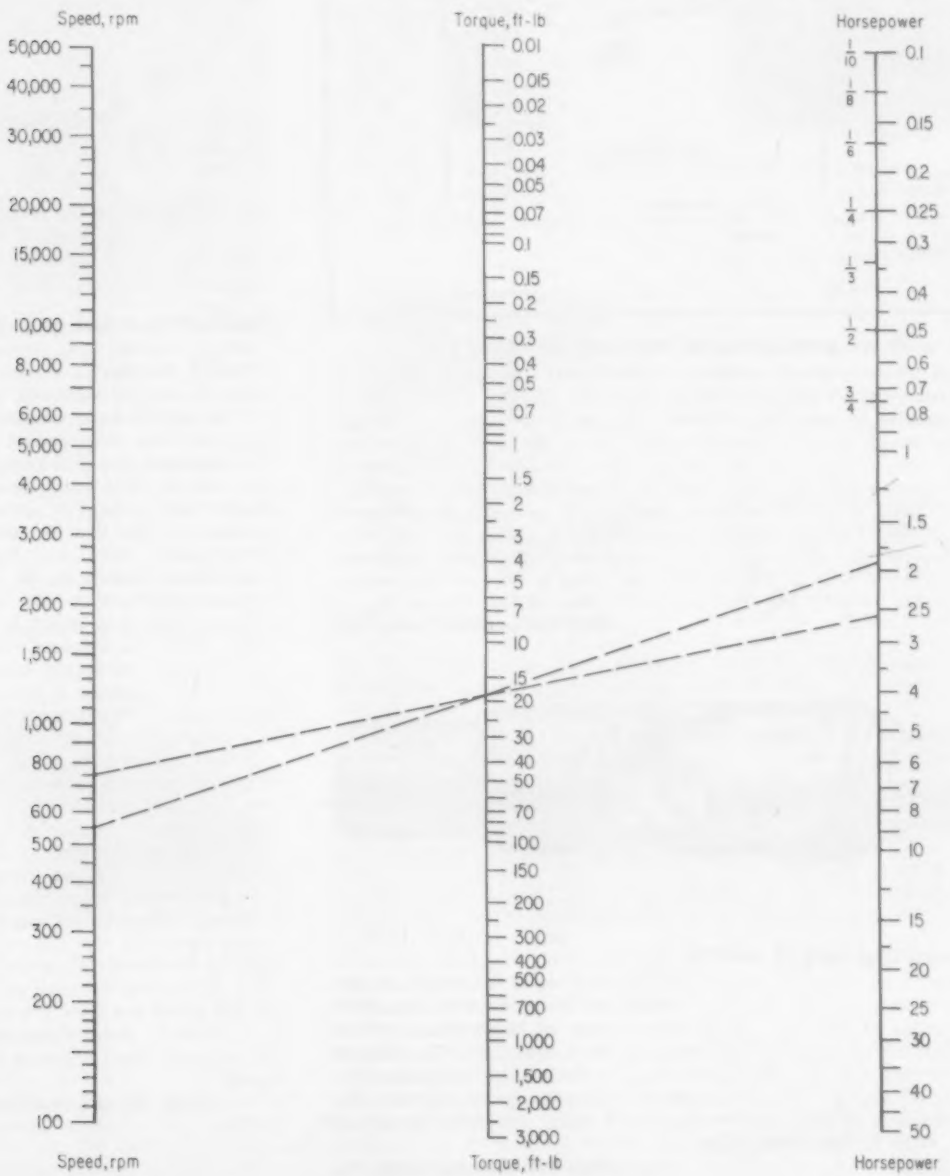
ANALYSES: All alloy grades in steel and cast iron, including heat and corrosion resistant stainless steels, plain carbon steel and special non-standard analyses.

FINISHES: As cast, rough machined, or finish machined, including honing and grinding. Complete welding and machine shop facilities are available.

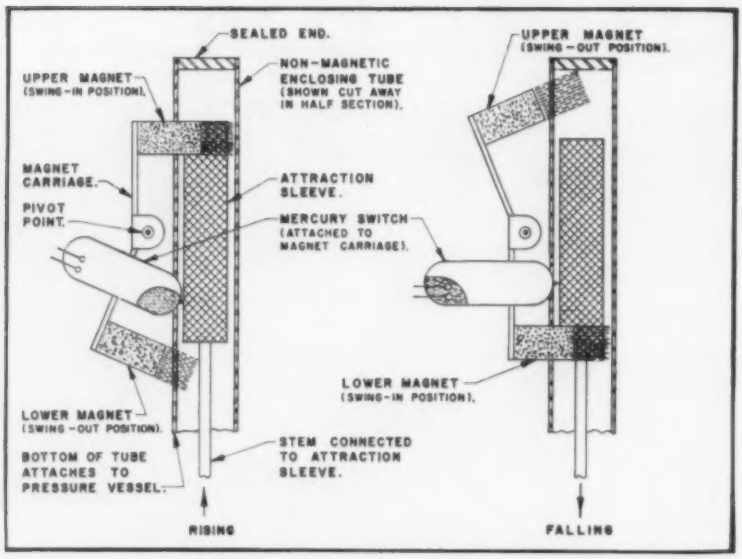
Example: Choose a motor for a constant-torque drive that is to deliver 18 ft-lb torque at 490 rpm. Motor speed must vary from 0 to 750 rpm.

Solution: Since this is constant-torque drive, the motor must be able to deliver 18 ft-lb at the maximum speed, 750 rpm. Reading directly off the nomograph, a 2.6-hp motor meets these conditions. Adding 10% for transmission losses brings the required rating up to 3 hp.

Another look at the nomograph shows that if top speed is reduced to 550 rpm, a 2-hp motor will do, cutting costs for motor, controls and power supply.



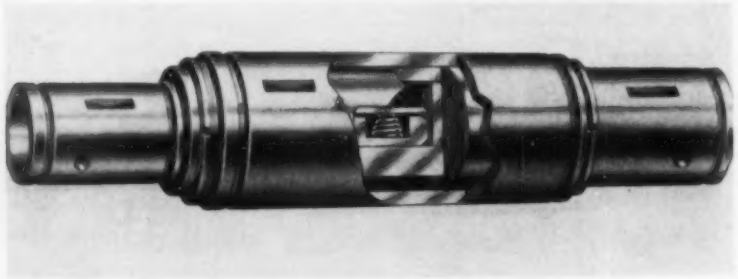
SIGNIFICANT COMPONENTS MATERIALS, PROCESSES



Air valve with magnet-operated mercury switch . . .

is designed for pneumatic-circuit, liquid-level or flow-control applications under severe vibration. Splashing of mercury across contacts is prevented by tilted position of switch and dampening effect of wave-shape electrode. For liquid-level control, all-stainless, three-way valve permits air to flow from air supply line directly to pneumatic actuator (or diaphragm valve, air cylinder or other device) when liquid level reaches maximum limit. At low level, supply air is cut off and air entrapped downstream is vented to atmosphere. Operates against 40 psi max as standard and up to 100 psi with special construction. Either single or double-pole mercury switch actions are available, to close up to four circuits. Either splashproof or explosionproof housings can be furnished. Rated 4 amp at 115 v ac, 2 amp at 230 v ac, 1 amp at 440 v ac. Max temperature for mechanism is 450 F. **Magnetrol Inc, 2110 S Marshall Blvd, Chicago 23.**

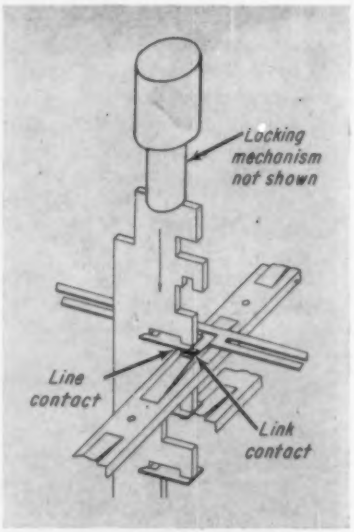
Circle 300 on Reader Service Card



Straddle-mounted torque control . . .

utilizes patented wedge-action lock bar (see cutaway) to prevent driven-member torques from overcoming driving-member torques. Input torque in any direction immediately permits free rotation of driveshaft. Spring-loaded locking bar always remains wedged against outer lock-ring unless pressure is directly applied to input shaft. Sleeve-bearing design is modification and size reduction of previous models, which incorporated two sets of double ballbearings. Units are made of heat-treated, precision-ground alloy steels. Load capacities are available from 50 to 26,000 in.-lb. **Ann Arbor Bearing and Mfg Co, 815 Wildt St, Ann Arbor, Mich.**

Circle 301 on Reader Service Card



Pushbutton crossbar switch . . .

is said to eliminate wiring large matrix of individual switches and also to replace conventional patchcord switching. Handles signals from microvolt dc to megacycle range. Has constant characteristic impedance throughout switch of 75 ohm and handles high-frequency signals. Because noise induced in contacts from actuators is less than 5 microv and thermoelectric noise less than 0.01 microv/deg C, switch can be used with low-level thermocouple and strain-gage signals. Contact is closed by pressing button. If button is rotated, contact will remain closed indefinitely without any extra control equipment or power supplied to the switch. Vertical marking on button indicates whether contacts are open or closed. Breakdown voltage between switching conductors and frame and across switch contacts is 1000 v ac. Insulation resistance from conductors to frame and between conductors runs to 1 million megohm max. Contact resistance of twin gold contacts is between 10 and 20 milliohm. Conductor resistance through longest path is 0.3 ohm and contacts will carry up to 3 amp. Cross talk is −60 db at 10 mc with 100 ohm termination. Six-pole switch that is 10 x 10 costs $370; 20 x 10, $690. **James Cunningham, Son & Co, Inc, PO Box 516 Zone 2, Rochester 8, NY.**

Circle 302 on Reader Service Card

Overload safety device . . .

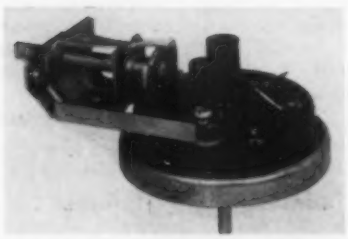
for equipment with power transmissions prevents breakdowns due to overloading. Made of carbon steel, device is lubricated for life. Clutch facing resists moisture expansion and achieves more constant torque. Carbon steel flanges in contact with clutch facings are surface ground to approximately 32 micro-finish. Device has induction-hardened bearing race, easily installed and adjusted torque-adjusting nut and machine-squared threaded hub and pressure plate. **Dalton Gear Co, 1750 Hennepin Ave, Minneapolis.**

Circle 303 on Reader Service Card

Sprockets, gears and pinions can be flame-cut . . .

by natural-gas-and-oxygen process said to achieve close tolerances and surface finishes. Process can provide special gears of any design in quantities from one to thousands without pattern, templet or tooling changes. Thicknesses can be cut up to 28 in. without sacrifice of surface finish. Materials include high- and low-carbon steel, manganese and silicon steels, high-carbon nickel, nickel-chromium and molybdenum steels. Min practical thickness is ¼ in.; tolerance at this thickness is +0.030 in. Reported to provide custom gears in production quantities at less than the cost of castings. **Reliable Steel Plate Co, 2330 E 79th St, Cleveland 4.**

Circle 304 on Reader Service Card



Adjustable liquid-level control

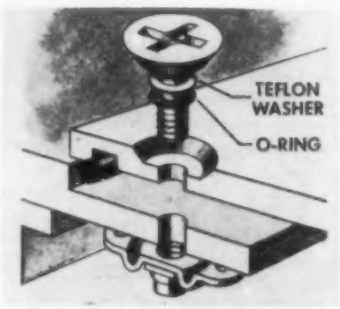
permits choice of variety of settings within one of several ranges. Can be furnished with noncorrosive parts for marine-pump applications and with built-in time-delay mechanism. Housed within switch, time-delay mechanism prevents foreign matter from altering normal switch operation. Single-level pressure switch is also available, providing one trip and reset calibration. UL-listed for 10 amp at 250 v ac; 15 amp 125 v ac; ½ hp at 125/250 v ac; 20 amp at 250 v ac noninductive; 3 amp at 125 v ac pilot duty. Available from stock. $7 each. **Controls Co of America, Appliance & Automotive Div, 9555 Soreng Ave, Schiller Park, Ill.**

Circle 305 on Reader Service Card

12-position rotary switch . . .

is available in 1 to 25 sections and with variety of contact arrangements. Detent action gives positive positioning at 30° intervals. Contacts and terminals are silver. Switching action, which can be shorting or nonshorting, is wholly contained within insulated enclosure formed by molded section-elements. Interrupting rating is 5 amp at 125 v ac unity power factor. Mounts with four 10-24 screws on 3¼ in. bolt circle. It measures 2$\frac{13}{16}$ in. sq and extends 3$\frac{13}{16}$ in. behind mounting panel for 1-section unit; 12⅜ in. for 25-section unit. The 1-section unit weighs 18 oz; 25-section unit, 5 lb 10 oz. **Electro Switch Corp, King Ave, Weymouth, Boston 88.**

Circle 306 on Reader Service Card



Flush structural fastener . . .

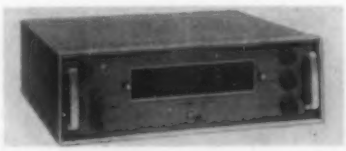
has self-sealing O-ring, which is always under controlled confinement with full metal-to-metal contact of faying surfaces. Reported to seal, without leakage, at high or low pressures or at vacuum. Many types of O-rings can be supplied to meet sealing requirements. Fastener is reusable. **Aero Bolt & Screw Co, 1071 W Arbor Vitae, Inglewood, Calif.**

Circle 307 on Reader Service Card

Printed contact relay . . .

molded in high-impact plastic for direct mounting on printed circuit board, is said to offer savings in cost, space and weight. Preadjusted contacts of bar palladium in armature assembly make direct contact with conductors on board. Shorting bar operation achieves any switching combination up to 3PDT. Single relay can control up to six circuits determined by printed cicruit design. Permanent magnet is employed in place of spring to hold relay armature open. Application of electromagnetic field opposing field of permanent ceramic magnet causes relay to operate. Available with operating voltages of 6, 12 and 24 v dc, and respective coil resistance ±10% of 125, 500 and 2000 ohm. Operate time is 10 ms at rated voltage. Normal life is 5 to 10 million cycles, depending on current. For use in ambient temperatures to 158 F max. Weighs 0.8 oz; measures $\frac{7}{8}$ x $\frac{7}{8}$ x 1$\frac{13}{16}$ in. Priced under $2, depending on quantity, number of poles, special characteristics. **Components Div, Executone Inc, 47–37 Austell Pl, Long Island City 1, NY.**

Circle 308 on Reader Service Card



Digital voltmeter . . .

is transistor-equipped and covers range from 1 milliv to 1099.9 v dc. Sensitivity is said to be 1 milliv and sensitivity control is continuous from 1 to 10,000 digits, with standby lockout. Measures 19 x 5¼ x 15½ in. deep, with brackets for rack or bench mounting. Unit has dust-proof switch and bridge section. Suitable for use in rugged industrial environments. **Cubic Corp, San Diego 11, Calif.**

Circle 309 on Reader Service Card

Fast-acting midget dc relays

are offered in two basic types, with several modifications including plug-in types, printed circuit types and models for use with ac, using built-in full-wave diode rectification. Available for voltages between 1 and 125 v; contact combinations up to 4C. With 2 form C, unit measures ¾ x 1$\frac{5}{32}$ x 1$\frac{5}{64}$ in.; sensitivity is reported to be 85 milliw. Contacts are rated up to 5 amp for switching resistive loads of 150 w max. Rated for life of 100 million operations. Clear plastic snap-on dust cover removes without tools. Priced, for example, at $1.45 each for 6-v-2 form C or $1.65 each for 6-v-4 form C in lots of 5000 or more, FOB Chicago. Samples from stock; larger orders, about 3 to 4 wk. **Caine Electronic Sales Co, 4120 W Lawrence Ave, Chicago 30.**

Circle 310 on Reader Service Card

Miniature accelerometer . . .

has dynamic error band (including linearity, hysteresis, resolution and repeatability) said to be as low as ± 1%. Friction-free multiplying potentiometer pickoff device,

continued on page 62

using flexure principle, eliminates all bearings. Offers resistances of 1 to 10 kohm; power rating 0.5 w at 165 F; damping, 0.5 to 0.8 of critical over-temperature range of —65 to 165 F; cross-axis acceleration error 0.01G/G max. Dimensions are 1.5 x 1 x 1 in. without mounting base and electrical connector. Good shock, vibration and acceleration characteristics and ability to withstand high altitude humidity exposure are claimed. **Bourns Inc, Instrument Div, 6135 Magnolia Ave, Riverside, Calif.**

Circle 311 on Reader Service Card

Interchangeable cylinders . . .

can be used without modification in either air or hydraulic systems at pressures to 200 psi air; 500 psi oil or water. Incorporates reverse trim packings and multiple-lip rod wiper that cleans in two directions to deliver dry rod on outstroke. Available in 21 different mountings and 11 bore sizes 1½ through 14 in., with strokes to specification. Piston seals and removable cartridge-retained rod seals are for operation at from —20 to 150 F. **S-P Mfg Corp, 30201 Aurora Rd, Cleveland 39.**

Circle 312 on Reader Service Card

Gearpumps . . .

are said to offer high volumetric efficiency and reduce frictional losses. Available in 72- 92- and 112-gpm capacities at 1200 rpm, 0 psi. Can be operated on most applications at speeds up to 2000 rpm and at system pressures to 1500 psi. **Hydreco Div, New York Air Brake Co, 9000 E Michigan Ave, Kalamazoo, Mich.**

Circle 313 on Reader Service Card

Plug-in time-delay relay . . .

for automatic and semiautomatic applications is offered in SPDT and DPST models with fixed or adjustable time delays (from 3 millisec to 300 sec). Remote time adjustment is also available. Timer uses cold-cathode tubes and requires no warm-up. Any number of timers can be connected for sequence operation. Operates on 105–125 v ac, 60 to 1200 cps. Size is 2 x 2½ x 3⅛ in. Weighs about 9 oz. Price is $19.75 list. Delivery, 2 to 3 wk. **G C Wilson & Co, Huntington, W Va.**

Circle 314 on Reader Service Card

Digital readout display . . .

operates directly from binary input and eliminates need for decoding device. Automatically decodes any BCD code up to six bits into numeric, alphabetic or special symbol character presentation. Can be used with digital computers, control equipment, instruments and other electronic or electric test equipment. Will work directly from teletype machine. Readout provides 16 digits or special characters and operates on light-interference principle. Displays 1½-in. character continuously until commanded to display new character and power may be removed without disturbing character on display. Operates on 10 milliw. Has check-back and verification circuits as well as storage readout. Dimensions of aluminum module are 3¼ x 1⅛ x 7 in. Weighs 2 lb 4 oz. Priced at $40. Delivery, 30 days after receipt of order. **Industrial Electronic Engineers Inc, 5528 Vineland Ave, North Hollywood, Calif.**

Circle 315 on Reader Service Card

Electric reset counter . . .

can be furnished with built-in pushbutton reset or with terminals for connecting remote reset switch or relay. Six-digit counter registers one count for each actuating impulse; operates at speeds to 1000 counts per min. Seven-digit counter and variations available in count to pulse ratio adapt counter to varied applications. Electric reset circuit requires 0.1 sec contact to make; total reset time, 2 sec. Standard units are for 120 or 24 v ac, 60 cps. Over-all dimensions are 6 x 4 x 5⅛ in. deep. **Pic Automation Controls Div, General Controls Co, 8072 McCormick Blvd, Skokie, Ill.**

Circle 316 on Reader Service Card

Stainless-housed synchro motor . . .

is reported to meet weight requirement of aluminum-housed synchros. Error curve of unit in aluminum housing is said to be affected more seriously by temperature variations than those built in stainless steel housings. Stainless housing is also said to offer light weight without expansion and contraction encountered in aluminum-housed synchros. **Daystrom Inc, Transicoil Div, Worcester, Penna.**

Circle 317 on Reader Service Card

Hydraulic leakage meter . . .

can measure system leakage as small as 0.0025 cc. Meter is connected into line between test item and high-pressure fluid supply (up to 5000 psi). Any leakage displaces piston, which is separated from working fluid by bellows. This displacement is measured by position transducer and displayed on volume indicator dial. Max displacement is 2 cc. Operating periods can range from 15 sec to 5 min. Meter need not be close to equipment. Price, $2650. **Convair Instruments, Convair Div, General Dynamics Corp, 3595 Frontier St, San Diego 10, Calif.**

Circle 318 on Reader Service Card

Titanium-coloring process . . .

is also said to produce resistance to chemical corrosion and ability to remain color-fast to 600 F and legible after extended exposure to 1000 F. Coats titanium and its alloys in brilliant and uniform colors. Multicolors can be applied to single piece of titanium. Process can be controlled to produce electrically conductive or nonconductive coating. For impact extruding of titanium in mild applications, color coating serves as anti-

continued on page 64

Smaller Panels

WITH SQUARE D *"System-Designed"* RELAYS

CLASS 8501
TYPE DO-22

Write for Bulletin D.
Square D Company,
4041 North Richards Street, Milwaukee 12, Wisconsin

• Square D relays are available for both AC and DC systems—with up to 10 contacts—in both electrically and mechanically held forms. Timing relays are also available in AC and DC versions—with timing intervals from 0.2 second to 3 minutes.

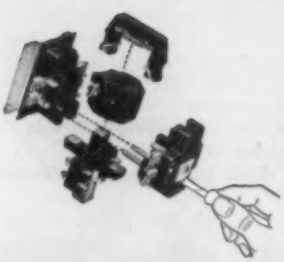
Both relays and timers give you these important advantages:

Require less panel space • Relays are only 3″ wide, range in height from 3¼″ to 5″. Timers are just 2⅝″ x 4⅜″ or 2½″ x 7²¹⁄₃₂″. Mechanically held relays require no extra panel space.

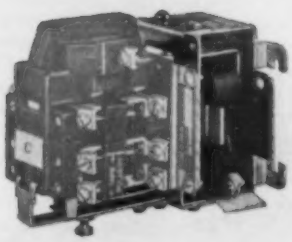
No mounting problems • All Type A timers and Type D relays have identical mounting hole dimensions.

Easy wiring • Choose either pressure wire connectors or slip-on connectors for all terminals.

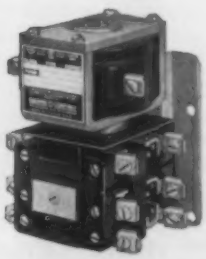
Long life • Balanced construction reduces wear on single moving part. Epoxy-resin molded coil operates cooler, virtually eliminates coil burnout.



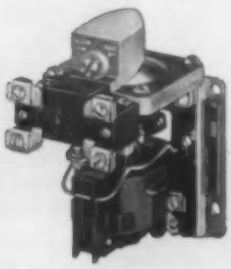
Disassembly from front in 20 seconds makes Square D Type D relays easiest to maintain



Convert any Square D Type D relay to mechanically hold with easy-to-use attachment



DC relays have contact arrangements and mounting hole dimensions identical to AC



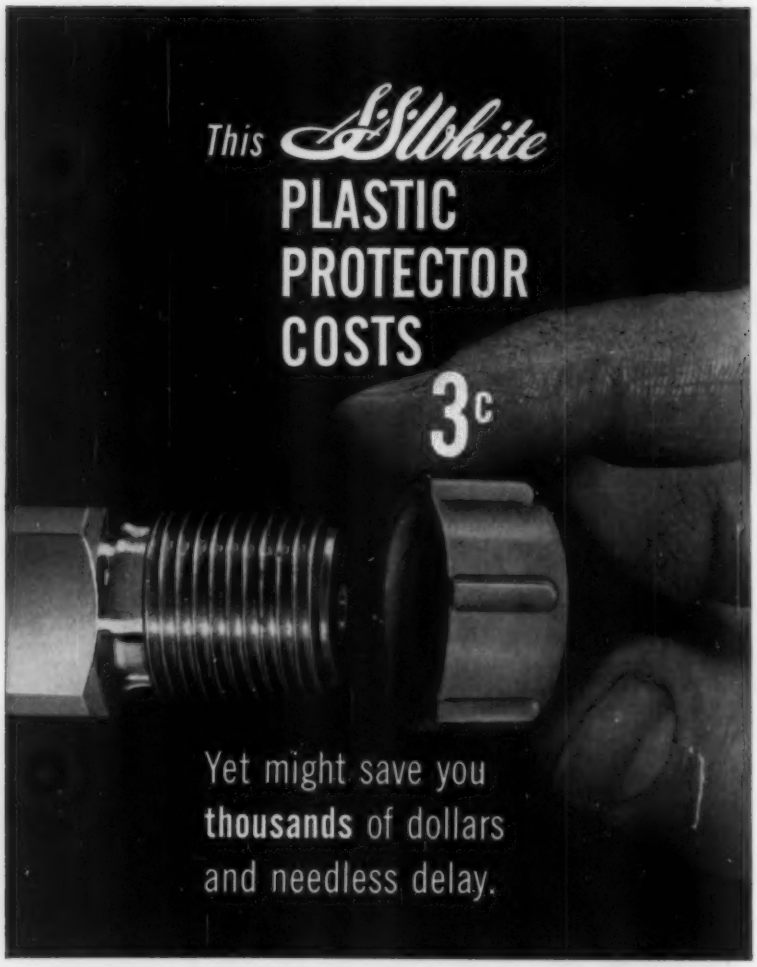
Timing relays convertible from on-delay to off-delay, using only a screwdriver

Square D offers the broadest line of relays, starters and accessories for all types of control systems

SQUARE D COMPANY

wherever electricity is distributed and controlled

CIRCLE 63 ON READER SERVICE CARD



For mere pennies you insure yourself *and your customer* against damage to your products during shipping, storage, processing. The economic facts are that simple.

S. S. White rigid acetate **Quality Line,** plastic protectors absorb blows like a Champion Heavy-Weight. Impervious to acids, alkalies, greases and oils, they seal in fluids, seal out dirt, dust, and anything else that might damage expensive equipment. Note this too... they remove *by hand* in a matter of seconds... and leave no shreds behind.

For even lower cost protection, look into S. S. White **Economy Line** elastic vinyl protectors. A good shock-absorbing, rubber-like material with a non-slip grip that makes removal a snap. Stays put too. Customers like this; saves them hours of production time.

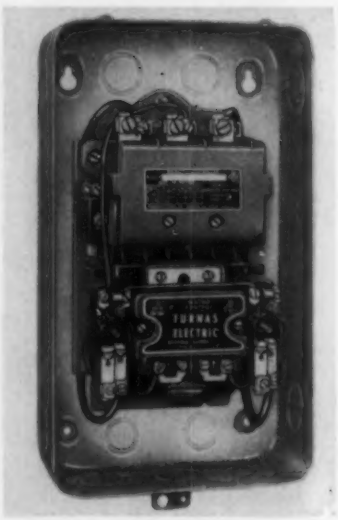
Start buttoning up customer good will today...

WRITE FOR FREE BULLETIN
P5708 and Samples

S. S. White **PLASTICS DIVISION**
Dept. 14P, 10 East 40th Street, New York 16, N. Y.

galling agent. In severe applications, coating is reported to act as lake to hold lubricant. Physical properties of base metal remain unaffected. Suitable for high-temperature nameplates, color coding of fasteners, valves and nuclear reactor components and for chemical pipes and fittings. **Hi-Shear Corp, 2600 W 247th St, Torrance, Calif.**

Circle 319 on Reader Service Card

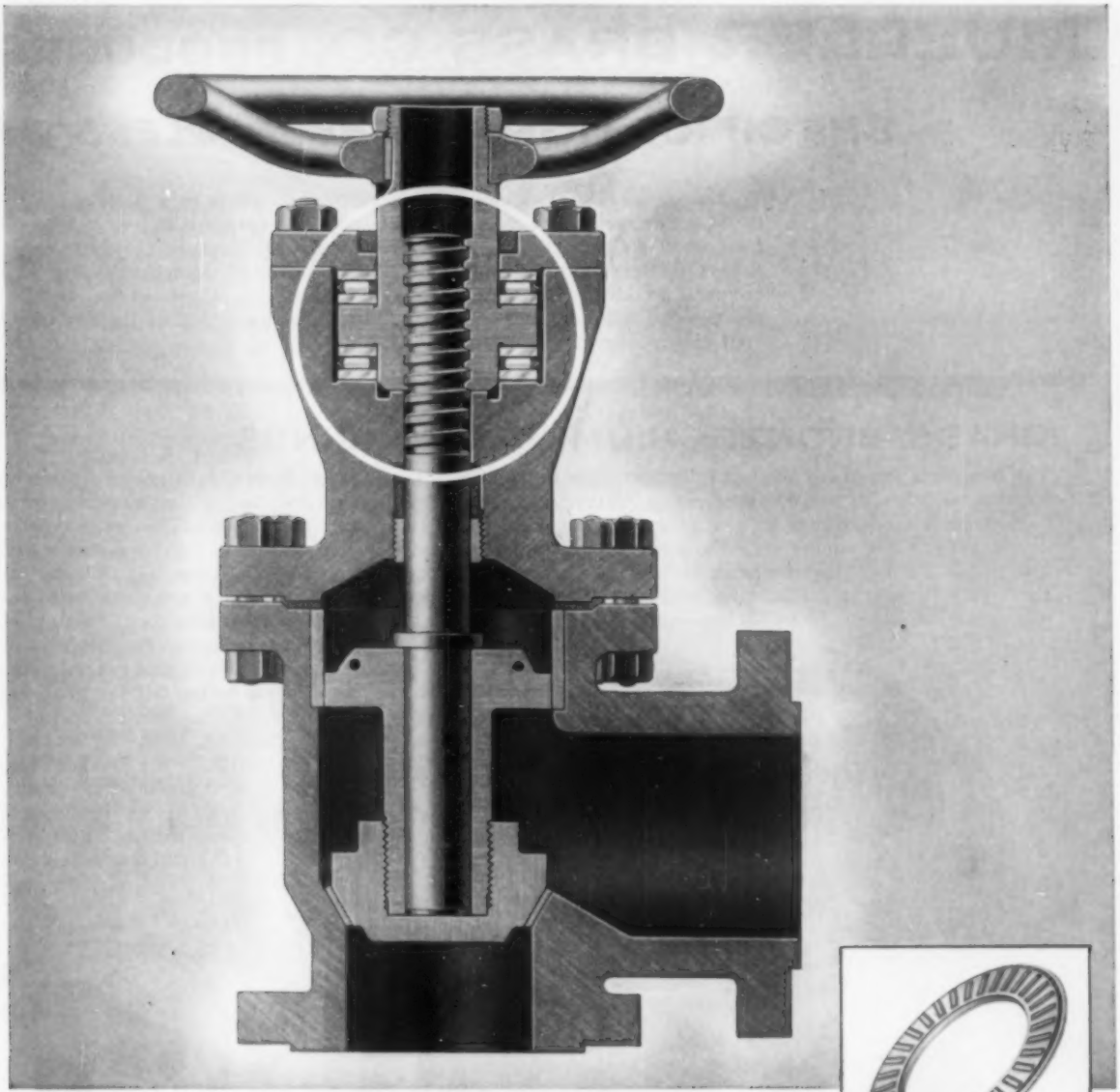


Magnetic motor starters . . . in sizes 2 and 2½ are for 2-, 3- and 4-pole applications for motor control through 30 hp, 550 v. Employ inherently trip-free thermal relays with visual trip indicators. Magnetic coils are molded type dual voltage (110/220 or 220/440), dual cycle (50/60 cps). Coil has molded terminal board. Features include unitized construction with all components front-removable; plug-in pushbuttons or selector switches, which can be added in field; pressure terminals; identical mounting area for both sizes. **Furnas Electric Co, 1050 McKee St, Batavia, Ill.**

Circle 320 on Reader Service Card

Hose coupling assembly . . . in ¼, ⅜, ½, ¾ and 1 in. ID sizes will fit any hose OD or wall thickness regardless of hose construction or type of service. All-purpose, reuseable hose nipple employs special stem to minimize abrasion within hose. Locks in three places in addition to clamp and nipple methods now in use. Assembly consists of one hose nipple and one yoke. Yoke is locked by two stain-

continued on page 68



Compact valve design, easier operation with Torrington Needle Thrust Bearings

High thrust capacity, thin cross section and low unit cost have made Torrington Needle Thrust Bearings a natural choice for top valve performance. With Torrington Needle Thrust Bearings, only a fraction of the normal closing effort is needed. This puts less strain on the valve... means smoother, more reliable operation. Lifetime pregreasing insures peak efficiency over years of extra service life.

Torrington Needle Thrust Bearings are exceptionally compact. They provide an assembled height far less than any other type of thrust bearing. They may be run directly on adjacent hardened and ground surfaces, or, as shown above, on standard Torrington thrust races.

If you make gate valves, globe valves, angle valves—in fact, any valve closed on a threaded stem—you'll find it pays to investigate the top efficiency of Torrington Needle Thrust Bearings. Call or write Torrington—maker of every basic type of anti-friction bearing.

Torrington Needle Thrust Bearing

Torrington Thrust Race

progress through precision **TORRINGTON BEARINGS**

THE TORRINGTON COMPANY Torrington, Conn. • South Bend 21, Indiana

MUELLER BRASS CO. PRODUCES

SPECIFICATIONS . . . *REGARDLESS OF*

To obtain the desired physical and design requirements in a part at the lowest cost, there is usually one specific process by which that part can be most successfully and economically manufactured. Because the Mueller Brass Co. offers a variety of production methods, you get sound engineering, accurate production method analysis, our assurance of getting the best product at the lowest cost . . . regardless of metal specified or the size of your particular part.

BRASS, BRONZE, ALUMINUM FORGINGS

The two parts shown here dramatically illustrate the ability of the Mueller Brass Co. to produce precision forgings regardless of size or configuration. Both the tiny dental drill nozzle and the big heat exchanger shell hub, which is the largest of its kind ever produced, were forged to exacting specifications. The weight of the nozzle is only a few ounces while the shell hub weighs 40 lbs., and has a forged pocket 7 1⁵⁄₁₆″ in diameter and 4³⁄₁₆″ deep. By way of size comparison, the pocket is big enough to hold over 14,000 of these tiny drill nozzles. By forging the pocket, considerable machining time and money was saved. The sound, dense structure of the shell hub makes it ideal for the high pressure application for which it was designed. The forging not only does the job better, but was produced for 25% less than the casting it replaced. Experience makes it possible for the Mueller Brass Co. to produce high quality precision forgings regardless of specifications . . . why not put this experience to work for you?

Write today for Engineering Bulletins on any of these Products.

SCREW MACHINE PRODUCTS

POWDERED METAL PARTS

ONE DEPENDABLE

MUELLER BRASS CO.

MUELLER BRASS CO.

PARTS ECONOMICALLY...TO EXACT

METAL, METHOD OR SIZE...

When you are designing, specifying or purchasing fabricated parts, call in the "Man From Mueller Brass Co." to help lower costs and improve your products. Sales and engineering service is available to you at Mueller Brass Co. offices throughout the United States. Make Mueller Brass Co. your one dependable source for all your part needs.

COLD PREST® IMPACT EXTRUSIONS

Today, because of vast experience in alloys, the Mueller Brass Co. has greatly expanded the possibilities of parts production by the impact extrusion method. Aluminum, of course, has been successfully used for a multitude of tubular shapes. But now it is also possible to impact parts of copper alloys incorporating such major advantages as: closer tolerances, better finish and appreciable metal savings. Because of dimensional accuracy possible with the impact extrusion, the necessity of secondary machining operations is often eliminated.

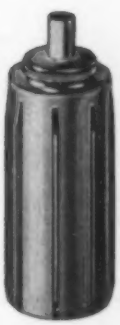
The parts shown here are representative of the group now being economically produced as impact extrusions by the Mueller Brass Co. who offer complete engineering and design service in the development of new parts from copper base alloys.

90-10 Copper Nickel Alloy

Aluminum Alloy 6061

Oxygen Free High Conductivity Copper

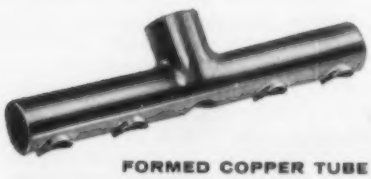
Special Alloy 902



Tellurium Copper Alloy

Low Phosphorus Copper Alloy

SOURCE FOR ALL THESE OTHER PRODUCTS



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STANDARD and SPECIAL ALLOY ROD

MADE IN U.S.A. TO THE STANDARDS OF AMERICAN INDUSTRY

PORT HURON 29, MICHIGAN

319

LOOK FOR THE DIAMONDS—SIGN OF FINISHING QUALITY

4

good reasons why you should use IRIDITE®

Chromate Conversion Coatings

FOR FINISHING ZINC OR CADMIUM

CORROSION PROTECTION—The wide range of Iridite coatings available gives you a choice of corrosion protection—from economical, mild protection of parts for shipment, storage or display, to extremely high protection under exposure to marine and highly humid atmospheres, gasoline or other hydrocarbons.

PAINT BASE—For an extremely tight bond for either baked or air-dried paints, nonporous Iridite blocks moisture penetration—prevents formation of metallic soap products beneath paint coatings.

APPEARANCE—Your choice of colors ranging from clear through yellow iridescent to olive drab. Bright Iridite finishes can also be dyed to provide other color effects.

SPECIAL EFFECTS—Iridite, in combination with other Allied Research processes, can provide a wide variety of finishes. As an example, Iridite 8-P applied to zinc or cadmium, followed by an application of Irilac, gives a highly attractive simulated brass finish.

IRIDITE—a specialized line of chromate conversion coatings for nonferrous metals. Easily applied at room temperatures with short immersion times, manually or with automatic equipment. Forms a thin film which becomes an integral part of the metal. Cannot chip, flake or peel. Special equipment, exhaust systems or highly trained personnel not required.

For complete information on Iridite, contact your Allied Field Engineer. He's listed in the yellow pages under "Plating Supplies." Write for FREE TECHNICAL DATA FILES.

Allied Research Products, Inc.

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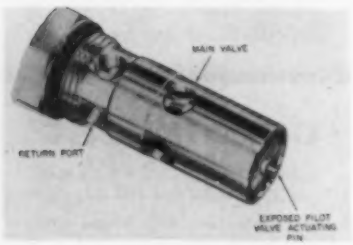
BRANCH PLANT: 400 MIDLAND AVENUE • DETROIT 3, MICHIGAN
West Coast Licensee for Process Chemicals: I. H. Butcher Co.
European Agents: Stora Gronbergar, Storgatan 10, Stockholm, Sweden
Chemical and Electrochemical Processes, Anodes, Rectifiers, Equipment and Supplies for Metal Finishing

IRIDITE® Chromates | IRILAC® Coatings | ISOBRITE® Brighteners | ARP® Supplies | WAGNER Equipment

less steel clamps, one on top of the other, piggyback fashion. In addition, nipple is held in place by yoke tie-ends and at third locking point by anchoring force of yoke upon nipple. All five sizes of hose couplings are available in NPT and BS-21 taper pipe threads. **Band-It Co, 4777 Dahlia St, Denver 16.**

Circle 321 on Reader Service Card



Cartridge relief valve . . . that provides instant response to surge pressures in any hydraulic circuit plugs into any housing that has pump pressure and provision for return to reservoir. Pin and hole orifice at inlet pressure port is self-cleaning with pin moving in hole with changing pressures. Said to offer constant regulation of pressure between cracking and full open. System pressure is preset through spring tension on pilot valve. Valve has capacity of 30 gpm. There is differential of less than 100 psi from trickle and full flow and less than 50 psi between crack and closing pressures with no internal leakage or leakage below cracking pressure. **Fawick Hydraulic-Electronic Div, Fawick Corp, 9919 Clinton Rd, Cleveland 11.**

Circle 322 on Reader Service Card

Dual-wheel swivel caster . . . with step-down positive action brake is available also with four-position swivel lock for manual use on missile dollies and similar industrial applications. Rated at 2000 lb capacity per caster. Features two large concentric races of ball load bearing and Timken thrust bearing. Step-down brake is double-handled so that down kick stroke locks or releases. Brake is servo-activated for either forward

continued on page 72

SELECT THE VALVES TO MEET THE NEED!

Select from full lines to operate and control a single OEM product . . . or a plant's entire production line!

Modern manufacturing demands quality . . . and Schrader Valves have it. Complete lines give you almost limitless range in planning air circuitry. The many extras in all Schrader Valves . . . superb engineering, compactness, strength, easy installation . . . make for precision operation. Your Schrader distributor is fully stocked, not only with Valves, but Cylinders and Accessories. He can help you with factory-trained experts and proven ideas.

The complete range of sizes and types of air circuitry products is stocked and cataloged by your Schrader distributor. Consult the yellow pages or write Schrader.

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KEEP AHEAD WITH HAVEG

CUSTOM ENGINEERED FABRICATED SILICONE RUBBER

Today Haveg and only Haveg provides the high engineering qualities necessary to mold such difficult and complex parts . . . parts offering these important features.

1. **High Temperatures—up to + 600°F.**
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3. **Excellent Electrical Properties at High Temperatures.**
4. **Low Compression Set Characteristics.**
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6. **Wide Choice of Colors.**

Many highly specialized procedures are essential to produce the superior quality so closely identified with Haveg. Expert tool design and construction, rigid process control and complete testing facilities are but a few of the vital operations in Haveg's quality assurance program.

Haveg's versatile Reinforced Silicone Rubber Seals are being used with great success in aircraft, missile, electronic, appliance and other applications.

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Haveg's Silicone Rubber can be precision molded into components of every description . . . with close tolerances to meet the most exacting specifications.

Haveg's Silicone Rubber can be extruded. Tubing, strippings, gasket material and similar products are manufactured by this method in an almost unlimited variety of sizes and configurations.

Strict adherence to the highest of standards of quality control permits Haveg to guarantee the quality of every shipment of Fabricated Silicone Rubber.

For further information, send for your copy of our new brochure giving important data on this very versatile Haveg product.

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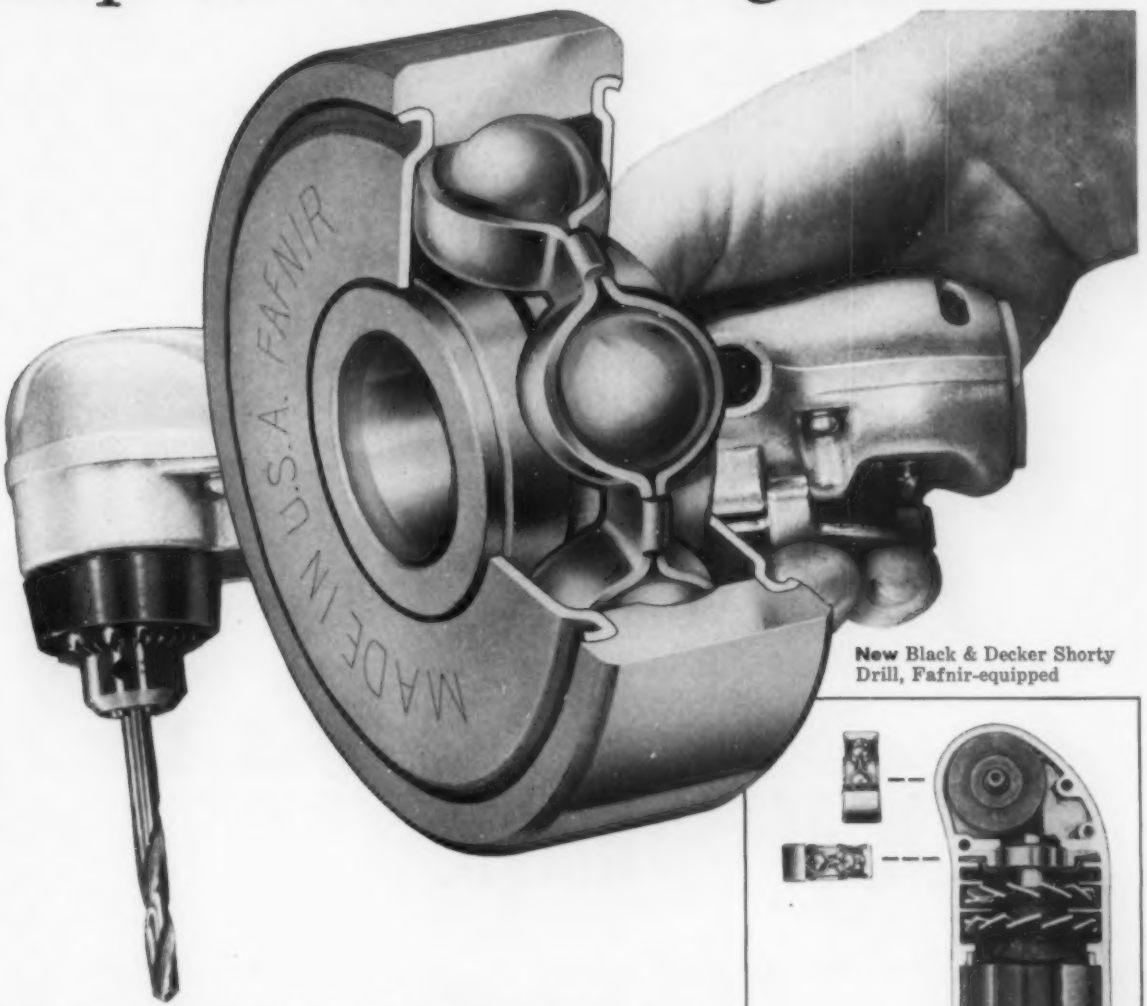
FAFNIR BALL BEARINGS
help new drill turn tight corners

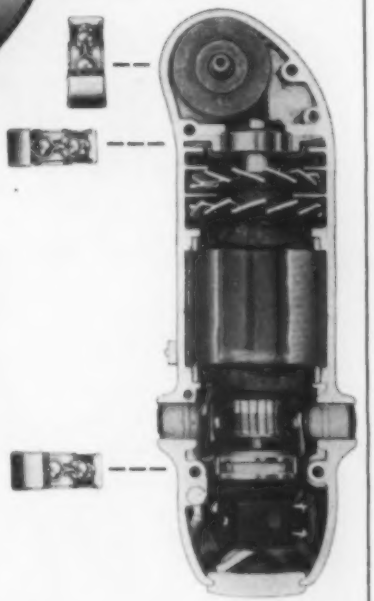


New Black & Decker Shorty Drill, Fafnir-equipped

Black & Decker's unique new "Shorty" Drill works where other drills won't . . . in tight spots . . . around corners. In this compact tool, Fafnir Ball Bearings meet space-saving requirements and provide the stamina and precision needed for heavy-duty drilling.

Fafnir extra-small shielded ball bearings are used on the chuck end of the spindle and commutator end of the armature. A third Fafnir Ball Bearing with Plya-Seal and Shield supports the fan end of the armature. All are permanently prelubricated, with their own built-in protection against grease seepage and contaminants. Thrust loads are adequately sustained by the ball bearings selected.

For the ball bearings *you* need, write The Fafnir Bearing Company, New Britain, Conn.



Fafnir Ball Bearings support armature and spindle in "Shorty" Drill . . . save space, maintenance . . . help keep parts rigidly aligned, true-running.

FAFNIR
BALL BEARINGS

rolls your ring troubles away—

Closeup of ring rolling, showing edging roll and portion of ring.

Edgewater ROLLED STEEL Rings

Your choice of diameter and cross-section —Complete, modern rolling, heat-treating and machining facilities enable us to produce steel rings *with precise accuracy* . . . in a large range of sizes and wide variety of cross-section shapes. Sizes are from 5 in. to 145 in. in diameter; shapes may be simple or complex. Edgewater rolling process minimizes finishing operations . . . provides rings of maximum strength, toughness and uniformity.

Meeting your specifications — Send us your drawings. We can furnish rings to closest tolerances or recommend revisions that will give you the best combination of performance and economy.

Edgewater Steel Company

P. O. Box 478, Dept. PE Pittsburgh 30, Pa.

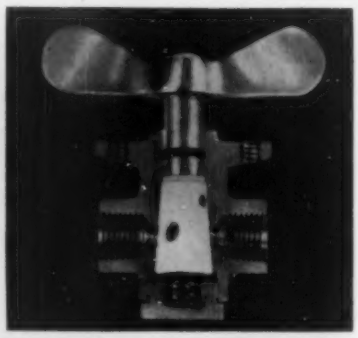
or backward movement and operator applies only light tripping force. 10-in. dia self-energizing rubber tired wheels incorporate sealed and adjusted bearings. Roll Rite Corp, 801 Jefferson St, Oakland 19, Calif.

Circle 323 on Reader Service Card

4-seal T-fitting . . .

eliminates need for adapters, connectors and special fittings when applying pressure gages or other instruments to hydraulic, pneumatic and process lines. Embodies four positive seals against pressure, temperature, vibration, surge, plus vibration dampener. Available in aluminum, brass, monel, steel and 316 stainless steel. Offered in sizes from $\frac{1}{8}$ through 2 in. dia with pipe thread. C B Crawford Co, 16606 Waterloo Rd, Cleveland 10.

Circle 324 on Reader Service Card



Valve has Teflon plug . . .

that seats against heavy-duty forged body, which is individually hand-lapped. Self-lubrication properties and low friction coefficient of Teflon eliminates need for oil or grease. Valves are for oil, air, water and gas service up to 250 psi at temperatures from —320 to 500 F. Said to be resistant to most chemicals, gases and solvents. Available in $\frac{1}{8}$, $\frac{1}{4}$, $\frac{3}{8}$ and $\frac{1}{2}$ in. IPS sizes with 2-3-4 or 5-way drillings. Brass bodies are standard. Conant Bros Co Inc, 427 Riverside Ave, Medford, Mass.

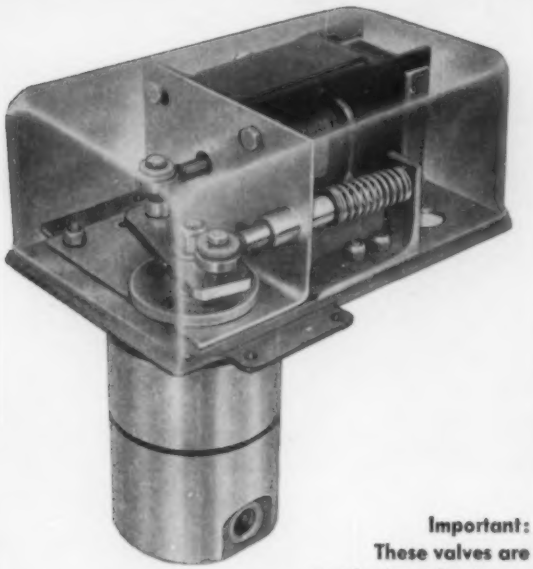
Circle 325 on Reader Service Card

Static contactors . . .

originally designed for missile and airborne applications are also suited for many industrial applications. Available in SPST, DPST, 3PST and 4PST models in production quantities with output of 10 amp at 115 v ac and input of 28 v at 125 ma. Also available with input characteristics from dry circuit to 20 amp ac or dc. Input values can be as low as 40 milliw. Temperature range is from

continued on page 76

10,000 P.S.I. SOLENOID VALVES



Important: These valves are standard catalog items.

● They are available for immediate delivery (in stock) at standard valve prices, for a service which generally requires costly (made-to-order) special valves.

● Shut off and 4-way valves in ¼, ⅜ and ½ inch port sizes are rated for 10,000 P.S.I. liquid or gases. They will withstand surges of up to 15,000 P.S.I. without damage to the valves' sealing qualities (designed for a burst pressure of 30,000 P.S.I.).
Solenoids are available for 115, 230 and 460 volt A.C. operation.

● Long maintenance-free service is achieved through the leak-proof "Shear-Seal" design. Optically flat metal to metal sealing surfaces (of the self-aligning sealing rings and the mating rotor face) are protected by staying in constant intimate contact: flow is always through the center of the "Shear-Seals," never across sealing surfaces. Sealing qualities actually improve as the seals lap themselves to a more perfect fit with each valve operation. There is no external shaft leakage because the pressure is confined to the flow passages.

For complete data write for catalog S-10000.

CONTROL VALVE DIVISION

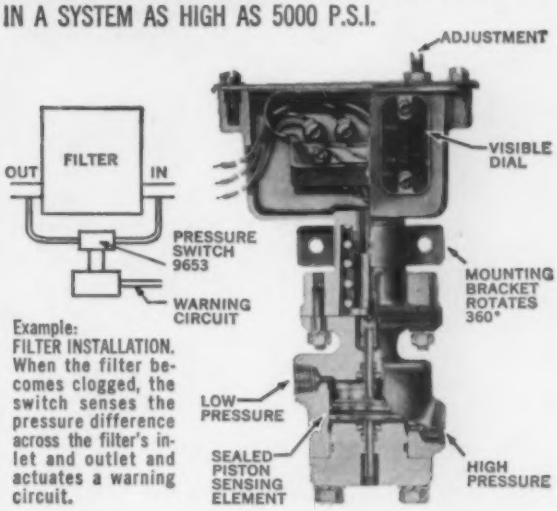
barksdale valves

5125 ALCOA AVENUE • LOS ANGELES 58 • CALIFORNIA

CIRCLE 205 ON READER SERVICE CARD

NEW PRESSURE DIFFERENCE SWITCH

SENSES A LOW DIFFERENCE OF 10 P.S.I. EVEN IN A SYSTEM AS HIGH AS 5000 P.S.I.



Example: FILTER INSTALLATION. When the filter becomes clogged, the switch senses the pressure difference across the filter's inlet and outlet and actuates a warning circuit.

The new Model 9653 is constructed to sense a difference from 5 P.S.I. to 140 P.S.I. between two pressures. A sealed piston sensing element actuates an electric circuit on increasing or decreasing of a predetermined pressure difference. It is applicable to oil systems ranging from 50 P.S.I. to 6000 P.S.I. working pressure. A high proof pressure rating of 9000 P.S.I. is your protection against damage from surges and shock loads. Field setting is simplified by means of an external adjustment screw and visible dial.

WE BUILD IN	WE DON'T USE
RUGGEDNESS Can take surges— (High proof pressures) Continuous operation— (Millions of cycles) No sticking— (in dirty fluid)	 **LINKAGES & BEARINGS** Which wear quickly —(cause settings to drift and switch to fail).
LABOR & MATERIAL SAVINGS No return drain piping— (Sealed piston) Mounts where convenient (Operates in any position, Not sensitive to vibration)	 **UNSEALED PISTONS** Which add to your installation cost (return piping). Are critical to dirt— (pistons get stuck).

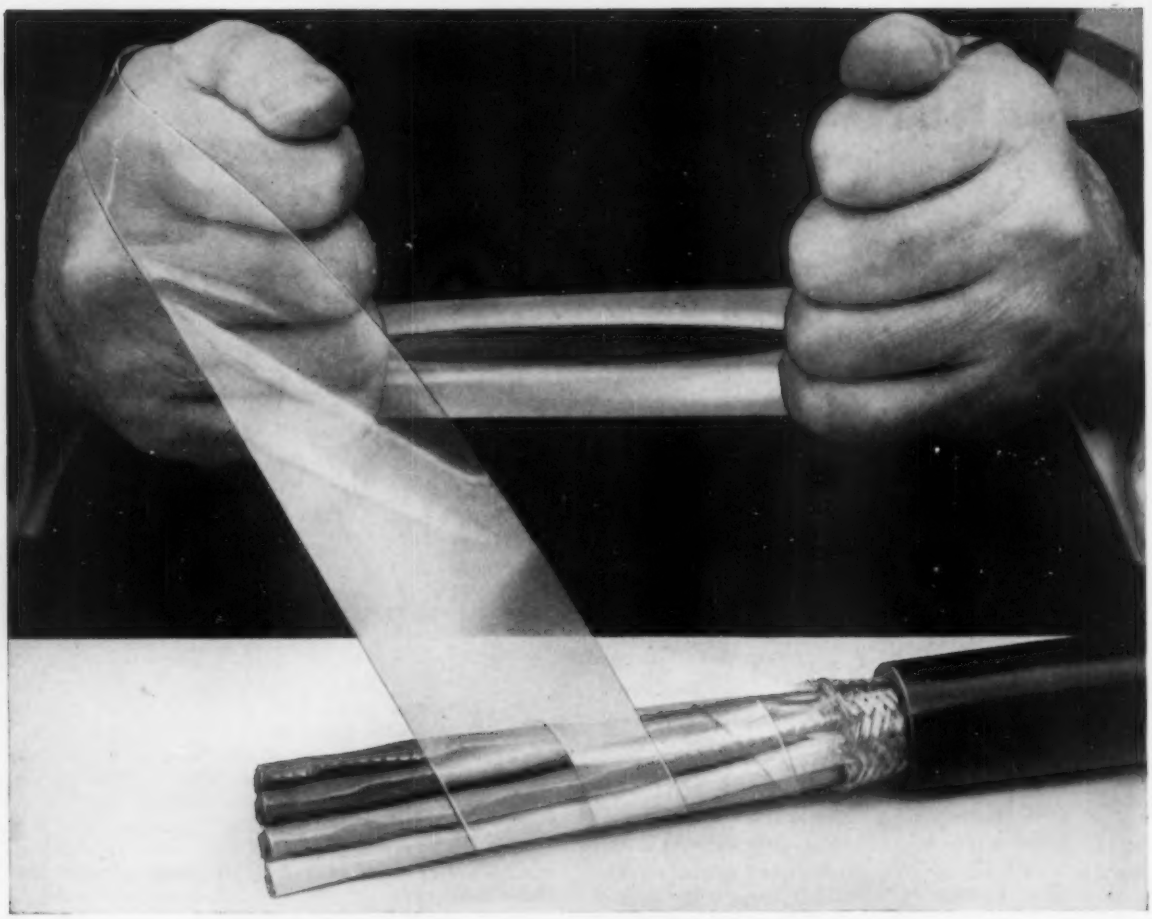
Ask for new pressure switch handbook and catalog '59-'60

PRESSURE SWITCH DIVISION

barksdale valves

5125 ALCOA AVENUE, LOS ANGELES 58, CALIFORNIA

CIRCLE 73 ON READER SERVICE CARD



Tough tape of MYLAR® cuts cable costs . . . reduces size, weight

Can the unique combination of properties found in "Mylar" help solve your design problems?

Tensile strength of 20,000 psi . . . Bowling-ball test offers dramatic proof of the amazing strength and toughness of "Mylar" polyester film.

"Mylar"* polyester film is a tough, flexible engineering material. Used as a core binder tape for electric cable, "Mylar" prevents sharp braid wires from puncturing the primary insulation during cable manufacture. Replacing heavier, thicker materials formerly used, "Mylar" reduces size, weight, cost of cable.

In addition to its average tensile strength of 20,000 psi, "Mylar" has excellent resistance to most chemicals and moisture, a dielectric strength of 4,000 volts per mil for 1 mil film, and can withstand temperature extremes from –60° to 150°C.

On an area basis, tough, thin "Mylar" often costs less than heavier, conventional materials. "Mylar" can be laminated, embossed and metalized, punched or coated. The film won't become embrittled with age. "Mylar" is available in roll or sheet form in a wide range of gauges.

Find out how the combination of properties in "Mylar" can help you solve knotty design problems, improve product performance or cut costs. Write today for our new booklet containing detailed information on properties and applications. E. I. du Pont de Nemours & Co. (Inc.), Film Dept., Room PE-10, Wilmington 98, Delaware.

*"Mylar" is Du Pont's registered trademark for its brand of polyester film.

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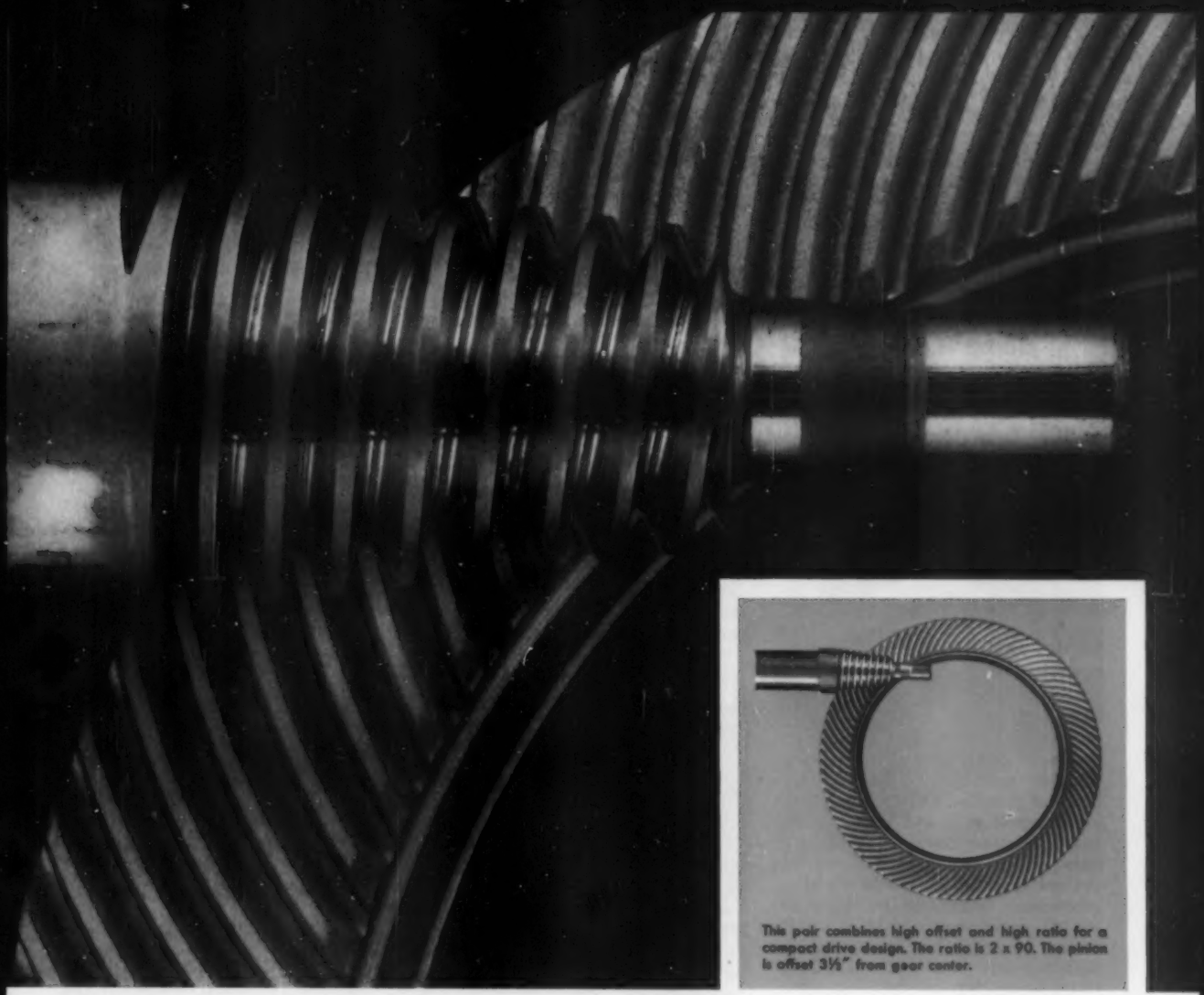
BETTER THINGS FOR BETTER LIVING
...THROUGH CHEMISTRY

DU PONT MYLAR® POLYESTER FILM



This pair combines high offset and high ratio for a compact drive design. The ratio is 2 x 90. The pinion is offset 3½" from gear center.

See how the teeth "wrap around" this high-reduction pinion

This is a high-ratio hypoid gear. In principle, it is not different from more conventional hypoids produced by the Gleason Works. *But . . .*

If you look closely at the pinion, you'll notice that the teeth tend to "wrap around" it. This design is extremely well suited for high reduction, strength and compact design.

The result is a conical (or sometimes cylindrical) pinion which permits *continuous tooth action—even with just one or two teeth!* Compared to corresponding bevel pinions, its diameter is greater for higher strength. An extended shank on cylindrical pinions makes *very rigid* straddle mountings practical.

You can design a *compact* unit, because high offset is possible! For high-offset *or* high-ratio pairs, the "wrap around" tooth design provides an extra measure of the smooth, quiet tooth action of hypoid gears.

High-ratio hypoids can be cut on the same Gleason equipment that is used on more familiar spiral bevel gears and hypoids. You can also use the same testers, quenching presses and other auxiliary Gleason equipment you're using now. Grinders are available for applications requiring precision finish.

High-ratio hypoids can be produced by the Gleason Works for ratios of 1:10 or 1:40 or even higher. They are finding a growing number of applications in such diverse fields as farm machinery, instrumentation and office equipment.

You can get more information about Gleason high-ratio hypoid gears by writing for free literature. Submit your prints for recommendations.

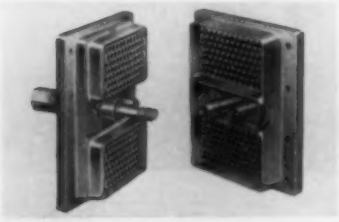
GLEASON WORKS

1000 UNIVERSITY AVE., ROCHESTER 3, N.Y.

CIRCLE 75 ON READER SERVICE CARD

—63.4 to 212 F. Silicon-controlled rectifier circuitry is reported to permit high-speed transfer functions while maintaining reliability in severe environments. Contactors are said to avoid contamination in storage, contact bounce, and malfunction due to shock and vibration. **Relay Div, Electronic Specialty Co, 5121 San Fernando Rd, Los Angeles 39.**

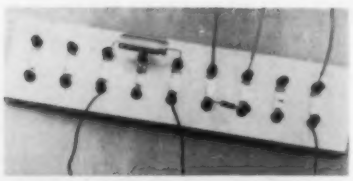
Circle 326 on Reader Service Card



Removable contact connectors . . .

are said to offer higher contact retention and lower millivolt drop. Available in single-or double-insert types, with die-cast aluminum shells, removable crimp style or solder type contacts, molded insert bodies of glass-filled diallyl phthalate, and interchangable male and female inserts. Jackscrew locking device on double-insert types provides alignment and recessed slot and matching guides achieve mating polarization. Immediately available in 81 and 162 contact connectors; 34, 42 and 50 contact connectors can be supplied on production basis. **General Products Corp, Union Springs, NY.**

Circle 327 on Reader Service Card



Temporary circuit connections

between electronic or electrical circuits are obtained by unit consisting of 20 rubber-core junction cells arranged in two parallel rows, with copper foil connecting each pair of cells. Wires are inserted by first pulling up on flexible rubber core at center of each cell. When core is released, rubber expands, gripping wire. Cells adjust automatically to various-diameter wires. Circuit elements, such as resistors, capacitors or diodes, can be inserted between cell units. **Plastic Associates, 2900 S Coast Blvd, Laguna Beach, Calif.**

Circle 328 on Reader Service Card

DESIGN LITERATURE

Physical and Engineering Properties of Cast Iron

HAROLD T ANGUS. The British Cast Iron Research Assn, Alvechurch, Birmingham, England. 7 x 9½, 528 pp. $11.

This book is an excellent source of engineering data. Most of the material in it was requested at one time or another, from the Development Dept of the British Cast Iron Research Assn.

It covers the structure of cast irons and their mechanical, physical and electrical properties. One section contains direct design data on cast iron components with high loadings—beams, columns, pipes, cylinders and pressure vessels.

This book is different—it is concisely written. The author was not afraid to devote only one sentence to subjects that did not require any more. Although this variation in subject length gives the book an inconsistent look, it makes the answers to your problem easier to find.

Classification of Electron Tubes

J HAANTJES, H CARTER. Macmillan Co, 60 Fifth Ave, New York 11. 8¼ x 11¾, 96 pp. $3.50.

Outstanding feature of this primer on electron tubes is wealth of large cutaway sketches in color: about three dozen tube types are covered. First chapters have elementary theory of tube electronics; subsequent chapters classify tubes by type (thermionic, cold-cathode, photo-cathode, pool-cathode) and discuss control, performance, and construction. If you've ever wanted a simple yet comprehensive reference to help you remember what goes on inside electron tubes, this is it.

Elementary Differential Equations

LYMAN M KELLS. McGraw-Hill Book Co, 330 W 42nd St, NY 36. 6¼ x 9¼, 318 pp. $6.25.

Originally published in 1932, this popular book has seen five separate printings and is now considered the standard text in more than 200 institutions throughout the country. This fifth edition has been rewritten to some extent and includes two significant additions: a chapter on Laplace transforms and a much expanded chapter on numerical solutions of differential equations. The latter addition has special importance today because it is the basis for solving differential equations on computers. Further, problems appearing at the end of each chapter have been revised and new problems added. Answers to the problems appear in the back of the book.

Transformers and Generators for Power Systems

R LANGLOIS-BERTHELOT. Philosophical Library Inc, 15 E 40th St, New York 16. 5¾ x 9, 541 pp. $12.

This single volume contains two complete books—one on transformers, the other on power generators. Each gives relatively complete theory on electromagnetic design, circuit parameters, insulation and heat transfer, and has an extensive bibliography of all important references. Each book is aimed at the engineering student with good knowledge of physics, and at the engineer designing or using motors.

Thermal Engineering

SOLBERG, CROMER, and SPALDING. John Wiley & Sons Inc, NYC. 6 x 9¼, 649 pp. $9.50.

An undergraduate-level text that gives broad introduction to later courses in thermodynamics, fluid mechanics and heat transfer. It covers these major topics: matter and energy; energy balance; thermodynamic properties of fluids; fossil fuels; nuclear reactors; internal-combustion engines; heat transfer; steam generation; heat exchangers; turbines; pumps; compressors and refrigeration.

Expendable Modules as Bases for Disposal-at-failure Maintenance

STONE, MEISSNER, SCHWARZ. Office of Technical Services, Dept of Commerce, Washington 25, DC. 8 x 10½, 79 pp. $2.25.

It is known that ordinary maintenance procedures cannot cope with new miniaturized, complex circuits, and expendable (throw-away) elements may be the only answer. But problem of disposal-at-failure maintenance is that cost may be excessive. This book attempts in a somewhat general

continued on page 81

When fastenings fail...

it may be your reputation that suffers most

When so much literally hangs on a bolted connection—as in this swing—the importance of a single nut becomes dramatically clear: *If the nut lets go, tragedy!*

In a sense the same is equally true of complex and costly products like farm equipment, washing machines, computers—or any other product you make that is subject to vibration when it is operating.

If your customers can't count on critical connections staying tight under punishing field conditions—and, even should the actual damage be slight—if they're faced with failure and expensive downtime because a nut lets go —you've had it when it comes to reorders!

The moral is clear. You simply can't afford to have your product's reputation for reliability ruined by fasteners that can't be relied on.

For more than 20 years, many of America's top manufacturers have relied on Elastic Stop® nuts to protect their product's reputations. They've learned that Elastic Stop nuts with their exclusive nylon locking inserts *simply will not work loose!* Not under the toughest impact, shock or vibration! Never! They stay put to give your product low cost insurance against fastener failure —the kind of insurance you can't afford to be without!

When you remember that reorders are written in your customers' maintenance records, you'll want to see how these leading companies protect the good name of their products with Elastic Stop nuts. Write for our interesting Bulletin No. 5901 Dept. S46-1045, Elastic Stop Nut Corporation of America, 2330 Vauxhall Road, Union, New Jersey.

ESNA®

for the ring of reliability

ELASTIC STOP NUT CORPORATION OF AMERICA

CIRCLE 77 ON READER SERVICE CARD

INVESTMENT CASTINGS

small
or
large

in any metal--ferrous or non-ferrous, including magnesium
in any quantity--production or prototype

Arwood's casting facilities enable us to cast parts that range from a fraction of an ounce up to 100 pounds. You now have a single source for small and large castings. It's just another good reason for doing business with Arwood.

- Five production plants throughout the country.
- Complete design, tooling and metallurgical research facilities.
- Eighteen years' experience in casting *all* the metals and alloys that can be poured into a mold – including everything from magnesium right through to stainless steel and difficult-to-machine superalloys.
- A time-tested record for reliability in meeting quoted prices and scheduled deliveries.
- Seventy-one trained engineering representatives coast to coast.

So . . . when the specifications call for an investment casting, you'll find that it pays to get a quote from Arwood.

Like to know more about investment casting? Send for our 44-page "Practical Guide to Investment Casting." It's yours for the asking.

Machine the simple . . . cast the complex

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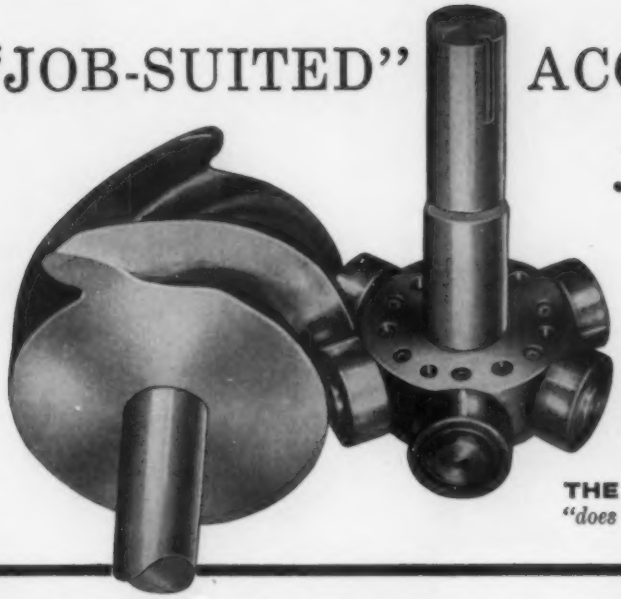

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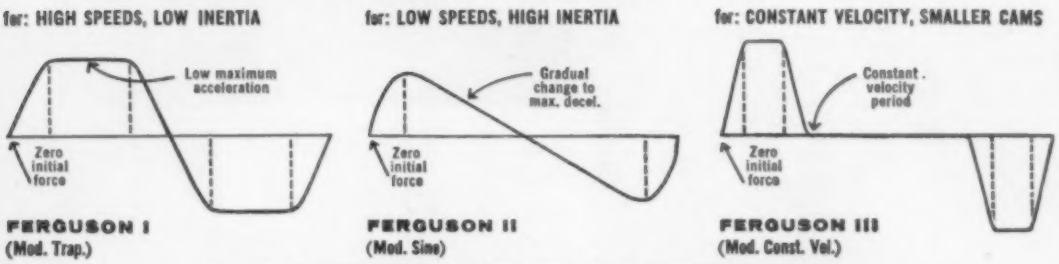

Three basic acceleration characteristics employed as dictated by the application

Dynamic design becomes increasingly critical as production machinery attains higher speeds. For this reason Ferguson Machine employs the "*Universal System of Cam Design Theory*" which utilizes the type of cam and acceleration configuration calculated to provide the best combination of operating characteristics for the motion desired.

A pre-selected configuration of the plot of **Acceleration** vs. **Time** is utilized for designing indexing mechanisms, plate, barrel and groove cams and index tables. Cam problems involving unequal times for acceleration and deceleration; compensation for external forces other than inertia; resilient driven members; matching of velocities and low input torque or low impact and centrifugal force requirements are thus taken into consideration and solved.

Movement Time is easily proportioned between **Acceleration Time** and **Deceleration Time** and, when necessary, **Constant Velocity Time.** Established tables based on unity displacement result in design flexibility which facilitates compensation for non-dynamic forces; minimizes vibratory action by considering special characteristics of the inertia load; provides constant velocity periods, etc.

"Job-Suiting" the acceleration characteristic, the only major improvement in the practical application of cams since configuration development itself, is a service much appreciated by Ferguson's customers. You, too, are invited to benefit by the special knowledge Ferguson has accumulated in the field of cam design . . . Send us the facts about any problem related to cam and machine dynamics . . . There's no obligation.

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CIRCLE 79 ON READER SERVICE CARD 79

Part Goes to Grace Plastic for Greater Durability

Automatic Milk Service, Inc. improved the performance of its coin operated milk vending machines through a change in design and material for one key part. The part is a chute through which milk cartons are dispensed. Produced the new way, it rarely requires repairs or maintenance.

The chute is subjected to rugged treatment every time the machine is operated (a carton of milk is released from above and hits the chute with considerable impact), and every time the machine is filled (the serviceman uses the chute as a platform to hold his milk case). Many different materials were tested for the part. Grace's high density polyethylene was chosen as the material that could withstand such abuse over a long period. The chute was redesigned for efficient vacuum forming with Grex sheet by Highland Products, Inc.

Chutes made from this Grace plastic stand up so well they rarely require attention. Even in cold weather, when other plastic materials lose their strength, these Grex chutes will not crack or break on impact.

For the vending machine company the use of Grex means longer chute life and lower maintenance costs. Perhaps you can reduce costs, too, by taking advantage of Grex for your products. The best way to find out is by calling in the experts. Grace has the production, technical and marketing facilities to help put your product in the Grex profit parade. Everyone says we're easy to do business with.

Grex is the trademark for W. R. Grace & Co.'s Polyolefins.

W.R. GRACE & CO.
POLYMER CHEMICALS DIVISION CLIFTON, NEW JERSEY

Large part designed with deep draws successfully vacuum formed from Grex sheet.

The experience of Highland Products, Inc. in redesigning and forming the chute for milk dispensing machines may give you some ideas on how to take maximum advantage of Grex for your *own* projects.

Simplification in design was the first step in production of the part. Originally it was a complicated assembly of nearly twenty pieces. The new design by Highland calls for only two large vacuum formed Grex pieces plus three flat Grex strips as stiffening members.

Deep draw required. In the interests of production efficiency and part performance, Highland's design calls for deep draws, straight walls and sharp corners. Such design requirements are difficult to satisfy in thermoforming many types of plastic sheet. The fact that satisfactory parts are being produced may be attributed to the thermoforming characteristics of high density polyethylene.

Slow cooling an advantage. High density polyethylene remains workable for a relatively long period. In this case, the Grex sheet is workable for 60 to 90 seconds after drawdown—sufficient time to obtain necessary detail on the sides of the pieces.

Want to know more about what can be accomplished by vacuum forming of Grex sheet? If you have an application in mind, give Grace Technical Service the opportunity to help you. We may not know all the answers, but we do have experience with high density polyethylene on our side—and are learning more every day.

Technical Service Department
W. R. Grace & Co., Clifton, New Jersey

way to compare economies of both techniques, and succeeds mainly in defining the problem, giving good equations and rules to follow for any set of circumstances.

Optics and Optical Instruments

B K JOHNSON. Dover Publications Inc, 180 Varick St, New York 14. Paperbound, 5½ x 8, 224 pp. $1.65.

An experimental rather than a theoretical approach to the study of optics. The author discusses, in turn, the eye, telescope, microscope, photographic lens, projecting system and optical glass; and describes the tests for measuring the performance of each. Those design engineers who must occasionally design optical systems will find the book a useful guide to practical tests and measurements of optical systems.

Other Books of Interest

Symposium on Hydraulic Fluids

American Society for Testing Materials, 1916 Race St, Philadelphia 3. 6 x 9¼, 102 pp. $3 members; $3.75 others.

German-English Science Dictionary

L DeVries. McGraw-Hill Book Co Inc, 330 W 42nd St, New York 36. 5 x 7¾, 592 pp. $7.

Barriers to Creativity

Industrial Relations News Inc, 230 W 41st St, New York 36. 8½ x 11, 32 pp. $1.50.

Decade-counter-tube Handbook

Sylvania Electric Products Inc, 1100 Main St, Buffalo. 8½ x 11, 12 pp. 15¢.

Research Program on High-vacuum Friction

PB 161116. Office of Technical Services, Dept of Commerce, Washington DC. 8 x 10½, 122 pp, plus appendices. $3.

Development of Low-alloy Steel Compositions Suitable for High-strength Steel Castings

PB 161044. H R Larson, R C Campbell, H W Lloyd. Office of Technical Services, Dept of Commerce, Washington DC. 8¼ x 10¾, 106 pp. $2.50.

Proceedings of the Engineering Materials and Design Conference (England)

Heywood & Co Ltd, Drury House, Russell St, London WC 2. 8 x 13, ½ in. thick. Approximately $5.70.

An Improved First-approximation Theory for Thin Shells

J L Sanders Jr. Superintendent of Documents, Govt Printing Office, Washington 25 DC. 8 x 10½, 11 pp. 30¢.

Calculus of Variations

A R Forsyth. Dover Publications Inc, 180 Varick St, New York 14. 5½ x 8½, 656 pp. $2.95.

Historical discussion of advanced mathematical procedures developed for the purpose of obtaining the most profitable result from imperfectly postulated data. Paperback edition of last English edition.

Flat-rolled Products—Part II: Semifinished and Finished

E W Earhart, R D Hindson. Interscience Publishers, 250 Fifth Ave, New York 1. 6 x 9¼, 150 pp. $4.

Proceedings of the 2nd Technical Conference of Iron & Steel Div, Metallurgical Society and Chicago section, AIME.

ABSTRACTS FROM THE LITERATURE

Pressure Forming of Plastics

Process is described and illustrated and some of the factors governing design of parts to be made by this procedure are discussed.

"When and How to Use Pressure Forming," E. A. Haddad. Modern Plastics, Aug '60, 575 Madison Ave, New York 22.

Translations of USSR Technical Literature

A list is provided of sources of translations of USSR literature in the fields of electronics, radio, controls, physics, acoustics and allied fields. Names of Soviet publications are given together with descriptions and names and addresses of sources of the translations in this country.

"Translations of Russian Technical Literature." Proceedings of the Institute of Radio Engineers, Aug '60, 1 E 79th St, New York 21.

Tetrafluoroethylene Bearings and Rings

Engineering and performance data on non-lubricated bearings and piston rings of TFE-fluorocarbon resins is

continued on page 83

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MAGNIFIED PHOTOGRAPHS OF FABROID

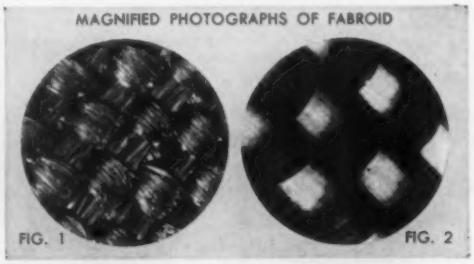

FIG. 1 FIG. 2

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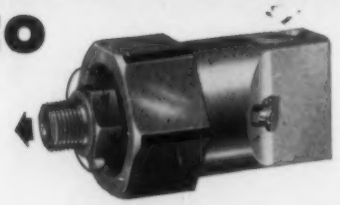

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presented. Included is information on reinforced molded bearings, thin coatings as bearing surfaces, impregnated bearings, TFE fiber bearings.

"Non-lubricated Bearings and Piston Rings of Tetrafluorethylene," R. B. Fehr, Jr, E. I. du Pont de Nemours & Co Inc. SPE Journal, Aug '60, 65 Prospect St, Stamford, Conn.

Engineer–Stylist Relationships

Two of the papers presented at the SAE National Farm, Construction, and Industrial Machinery Meeting, Milwaukee, Sept 12-15, were given by the engineer and the industrial designer involved in the development of a line of agricultural equipment. Each analyses problems, methods and benefits they discovered in the course of working with each other for the first time.

"The Stylist: The Engineer-Stylist Relationship," Richard Ten Eyck, Richard Ten Eyck Assoc. SAE paper 226A.
"The Engineer: The Engineer-Stylist Relationship," Ray Adee, Hesston Mfg. Co. SAE paper 226B. SAE, 485 Lexington Ave, New York 17.

CATALOGS AND BULLETINS

To obtain copies of literature described below, circle corresponding number on postcard inside back cover.

VACUUM-MELTED SUPER-ALLOY STEELS–Brochure, 16 pp. Presents information on consumable-electrode method and what the process achieves; lists advantages and properties of alloys produced by this method. Midvale-Heppenstall Co, Dept MV, Nicetown, Philadelphia.
Circle 350 on Reader Service Card

NYLON TUBING FOR INSTRUMENT-AIR SERVICE–Booklet, 15 pp. Describes properties, installation techniques and performance characteristics of nylon tubing in instrument-air service. Plastics and Coal Chemicals Div, Allied Chemical Corp, 40 Rector St, New York 6.
Circle 351 on Reader Service Card

AUDIBLE-SIGNAL EQUIPMENT–Bulletin K, 16 pp. Gives diagrams, specifications and mounting methods for all listed signal equipment. Section contains general information on various types of audible-signal devices and types that are most suitable for specific noise-level areas. Benjamin Div, Thomas Industries Inc, 207 E Broadway, Louisville, Ky.
Circle 352 on Reader Service Card

LIGHTWEIGHT WINCHES AND HOISTS–Catalog file, 10 data sheets. Catalog sheets cover features, construction, applications and installation diagrams

continued on page 85

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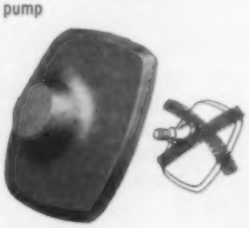

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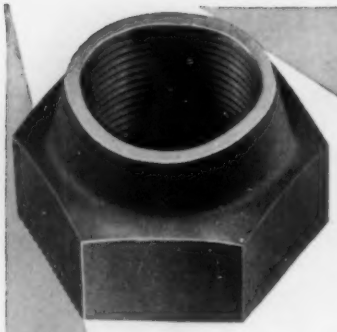

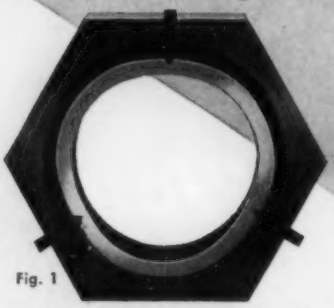

Fig. 1

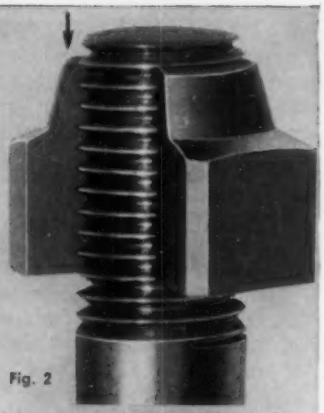

Fig. 2

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CONTINUOUS AND CONTOURED BACKUP RINGS—Catalog 5482, 8 pp. Describes characteristics of backup rings and discusses advantages of contoured and continuous rings. Dimensions and operating-media information are also included. Parker Seal Co, 10567 Jefferson Blvd, Culver City, Calif.

Circle 354 on Reader Service Card

POSITIVE-DISPLACEMENT BLOWERS—Bulletin S59H, 12 pp. Explains how horizontal and vertical blowers and gas pumps automatically provide metered quantity of oil-free air at constant volume, even against variable pressure. Also contains dimensional information on all models and sizes and performance data for low-, medium- and high-pressure units. Sutorbilt Corp, 2966 E Victoria St, Compton, Calif.

Circle 355 on Reader Service Card

ELECTRICAL CONNECTORS—Bulletin PR 259-1, 12 pp. Features, ratings and outline dimensions of single-conductor plugs and receptacles. Describes all 25-, 50-, 100- and 250-amp types offered. Superior Electric Co, Dept SPR, Bristol, Conn.

Circle 356 on Reader Service Card

INSTRUMENT PANELS AND DIALS—Catalog K, 8 pp. Describes facilities for producing instrument panels and dials, including finishing, engraving and silk-screening. Technical Enameling Co, Sub of Zero Mfg Co, 1208 Isabel St, Burbank, Calif.

Circle 357 on Reader Service Card

PRECISION ELECTRONIC CONNECTORS—Condensed catalog CC-860, 8 pp. Specifications, ratings and features of printed circuit, microminiature, subminiature, miniature and power connectors for missile, aircraft, computer and communication applications. Electronics Div, DeJur-Amsco Corp, 45-01 Northern Blvd, Long Island City 1, NY.

Circle 358 on Reader Service Card

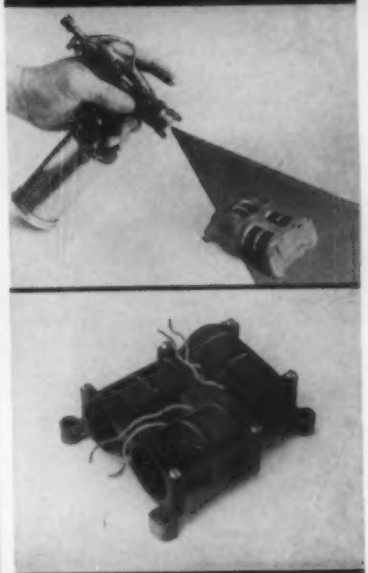
MICROMINIATURE RELAY—Bulletin, 2 pp. Electrical and mechanical specifications, dimensional diagrams and performance ratings for Type AR four-pole or two-pole microminiature relay and MTRH time-delay relays. Branson Corp, 41 S Jefferson Rd, Whippany, NJ.

Circle 359 on Reader Service Card

ADJUSTABLE SPEED OF SYNCHRONOUS INDUCTION MOTORS—Bulletin 111, 2 pp. Specifications of drive,

continued on page 87

Electrofilm



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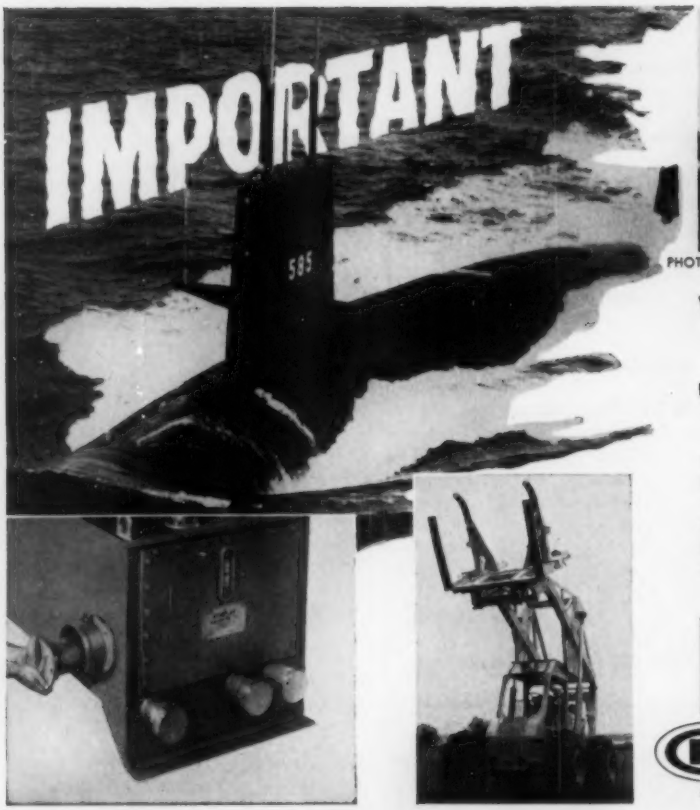

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drive motors. Describes power supply, control panel. Presents schematic layout. Louis Allis Co, 427 E Stewart St, Milwaukee 1.

Circle 360 on Reader Service Card

ILLUMINATED MAGNIFYING VIEWERS—Section IV, Catalog L-9, 4 pp. Dimensions, features and specifications of four different illuminated magnifying viewers. Fostoria Corp, Fostoria, Ohio.

Circle 361 on Reader Service Card

PROCESS FOR POROUS METALS—Brochure, 4 pp. Describes range of properties obtainable and applications of the process, which produces controlled porosity in stainless steel, iron-nickel alloys and other high-temperature metals. Mott Metallurgical Corp, 272 Huyshope Ave, Hartford, Conn.

Circle 362 on Reader Service Card

FLUOROSILICONE RUBBER—Bulletin 9-113, 4 pp. Contains typical properties and performance information on solvent-resistant silicone rubber. Typical applications are illustrated. Dow Corning Corp, Midland, Mich.

Circle 363 on Reader Service Card

SELENIUM RECTIFIERS—Brochure, 6 pp. Covers general characteristics, ratings and dimensions of varied constructions available. Edal Industries Inc, 4 Short Beach Rd, East Haven 12, Conn.

Circle 364 on Reader Service Card

OSCILLATING MOTORS—Catalog, 8 pp. Presents features, specifications and dimensions of single-vane and double-vane models. Roto-Tork Mfg Co, 23919 Little Mack, St Clair Shores, Mich.

Circle 365 on Reader Service Card

AUTOMATIC LUBRICATING SYSTEMS—Bulletin CL, 4 pp. Describes three types of automatic lubricating system that control oil feed and circulation rates, including components of system and pressure signal switch that makes operation of machine impossible unless it has adequate lubrication. Bijur Lubricating Corp, Rochelle Park, NJ.

Circle 366 on Reader Service Card

CARBON-FILM RESISTORS—Bulletin, 4 pp. Specifications, characteristics and ratings of standard, molded and hermetically sealed carbon-film resistors. Technology Instrument Corp, 531 Main St, Acton, Mass.

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SINGLE CRYSTALS OF REFRACTORY MATERIALS—Data bulletins, 4 pp. Contain preliminary information on single-crystal products, their physical prop-

continued on page 89

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Differential	factory set anywhere within limits of 1.5 to 5.0 psia
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Switch Types	single-pole, single-throw, snap-acting class R—NC—opens on decreasing pressures class G—NO—closes on decreasing pressures
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erties and purity, and size range (diameter and length) in which they are available. Linde Co, 270 Park Ave, New York 17.
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SINGLE-STAGE TORQUE CONVERTERS—Bulletin 511, 4 pp. Features, capacity range and standard approved arrangements of converter-transmission package for applications up to 300 hp. Twin Disc Clutch Co, Racine, Wis.
Circle 369 on Reader Service Card

SOLID-FILM LUBRICANT – Bulletin SL-126, 2 pp. Describes application and surface preparation procedures for air-drying solid-film lubricant containing molybdenum disulfide compound. Hohman Plating & Mfg Co, 814 Vermont Ave, Dayton, Ohio.
Circle 370 on Reader Service Card

WIDE-WIDTH MAGNETIC-SHIFT REGISTERS—Brochure, 4 pp. Discusses wide-width theory and presents circuit diagrams explaining functioning of data-control circuit, which reduces equipment requirements to one core per bit. Also gives typical characteristics of standard shift registers employing these principles. Magnetics Research Co, 255 Grove St, White Plains, NY.
Circle 371 on Reader Service Card

SILICONE-RUBBER INSULATION – Booklet, 6 pp. Covers characteristics and performance of silicone rubber insulation for wire and cable. With data charts, graphs and typical existing applications. Dow Corning Corp, Midland, Mich.
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X-RAY INSPECTION OF STEEL CASTINGS—Bulletin, 2 pp. Discusses requirements for various classes of X-ray specifications, relative extra costs of X-ray

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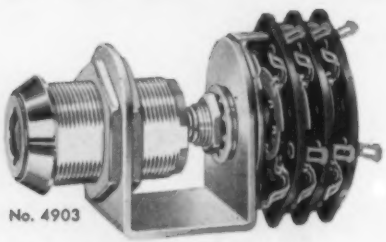

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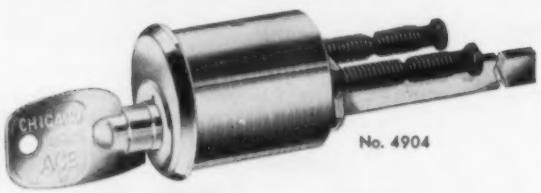

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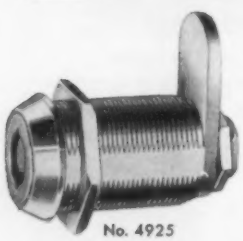

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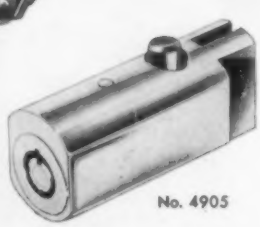

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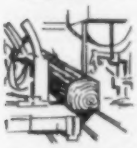

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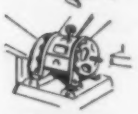

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PACKAGED PRESSURE-TO-VOLTAGE TRANSDUCER SYSTEMS—Data sheet, 2 pp. Covers specifications of systems incorporating variable reluctance pressure transducer and stable electronic circuitry in single package. Ultradyne Inc, 2630 San Mateo Blvd NE, PO Box 3308, Albuquerque, NM.

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SHOCK AND VIBRATION ISOLATOR—Bulletin 60-08, 2 pp. Specifications, construction and performance information on isolator that protects electronic equipment from shock, vibration and steady-state accelerations. Barry Controls Inc, 700 Pleasant St, Watertown 72, Mass.

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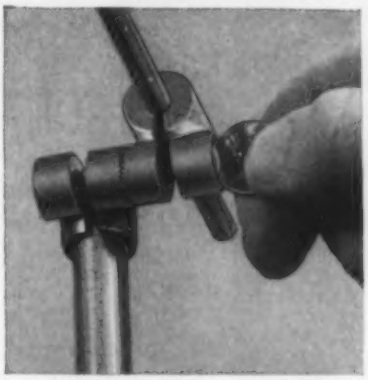

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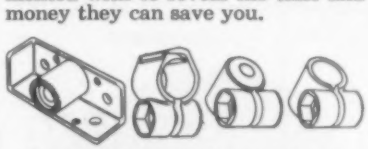

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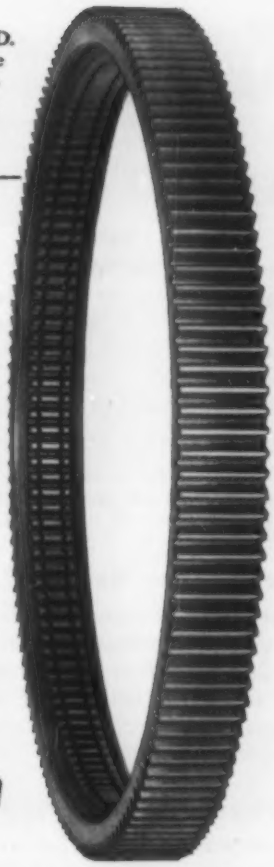

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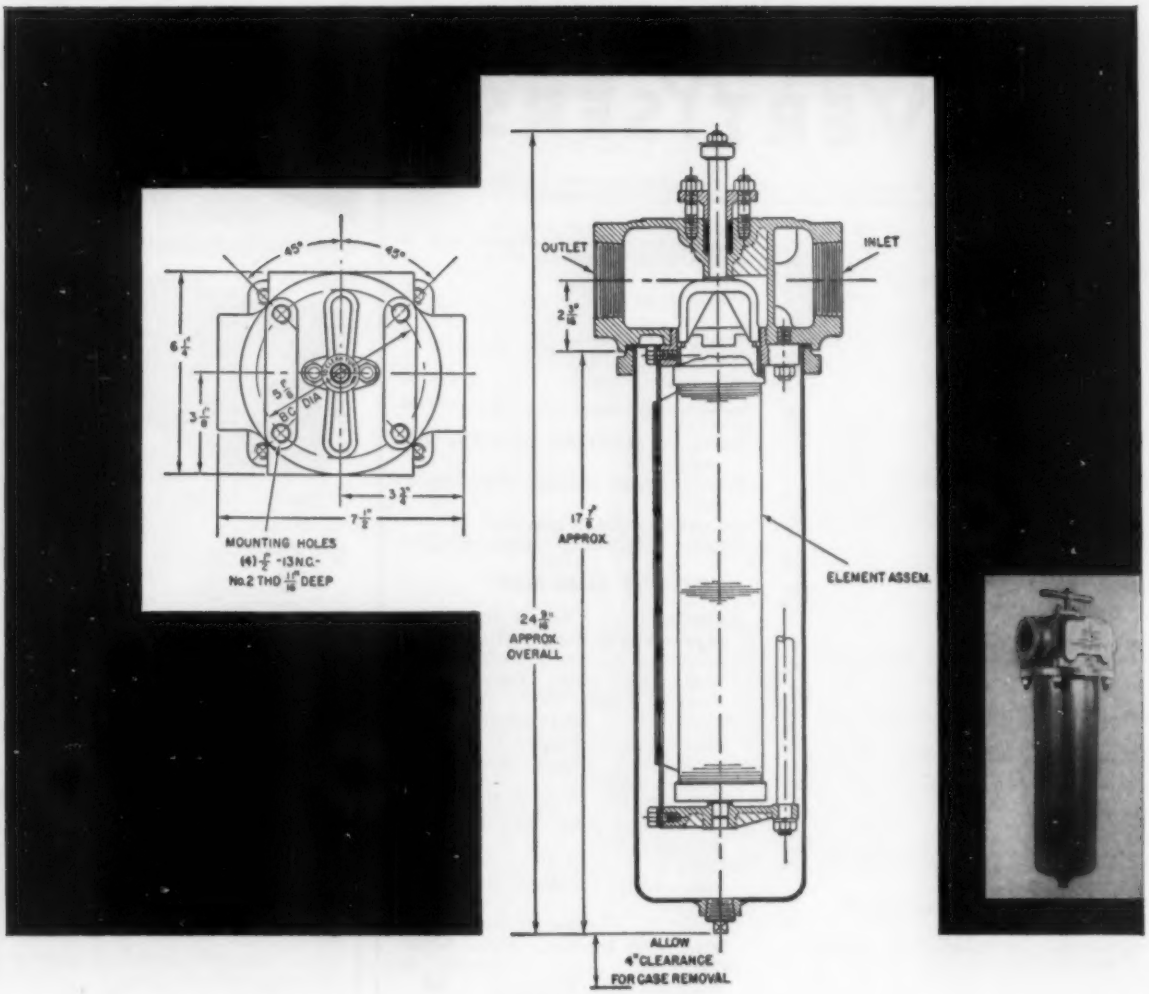

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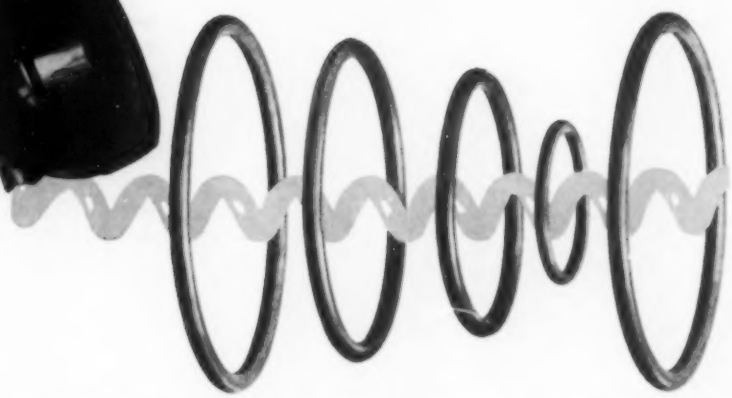

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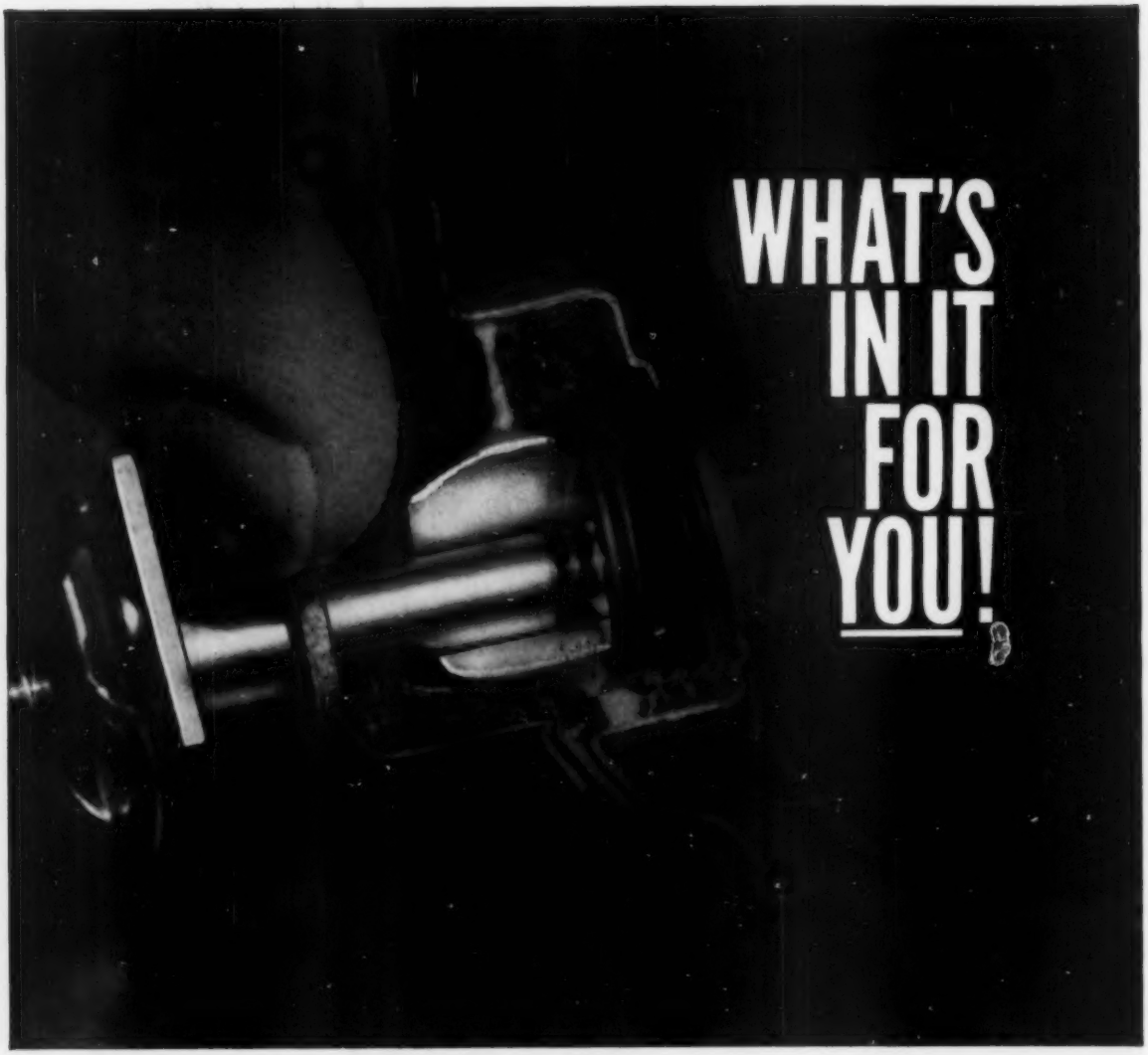
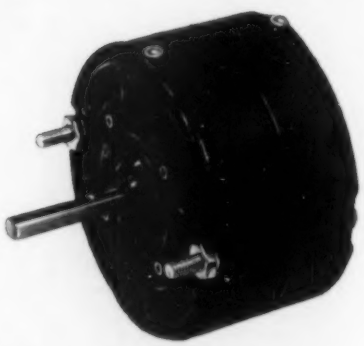


BEARING DESIGN OF
EMERSON ELECTRIC MOTORS

Is Self-Oiling, Self-Aligning to assure Free Starting and Smooth Operation at all times

—The bronze bearing in Emerson Electric Motors has thousands of tiny cells that cause the bearing to act as a metal sponge and feed the shaft journal a controlled flow of lubricant. In cooling, it draws off excess oil to give free starting at low temperatures. Self-Alignment minimizes friction and greatly increases motor life when you install *Emerson Electric Motors* in your appliances and equipment. Emerson Electric Motors are custom-engineered to meet your specific needs. Call us *today* . . . you'll like our way of doing business!



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